

This bulletin presents a method of illumination design which has become the standard for illuminating engineering work. Through its use tedious calculations of the "point by point" method are avoided; the time required is reduced to a few minutes; and even those not experienced in lighting design, by following carefully the steps as outlined, can at once apply these data with confidence.

The method of design is known as the "lumen method." It has the decided advantage that the technical considerations which are important as influencing the result and which require the experienced judgment of the engineer, have been taken into account in the preparation of the charts and tables and therefore automatically receive due allowance in the lighting design. The data apply primarily to interiors where standard types of reflecting equipment are used to obtain general lighting of substantially uniform level.

The experienced engineer may temper rule-of-thumb methods with judgment and secure satisfactory results, but, in the final analysis, all short-cut or recipe methods which are effective must be governed by principles as given in this bulletin. For the student, the essence of illuminating engineering will be found in a studied analysis of the factors which make up the tables in their present form.

Illumination Design Data for

Industrial and Commercial Interiors

A Handbook for Lighting Specialists, Electrical Contractors and Dealers, Engineers, Architects, Students, and Instructors

ENGINEERING DEPARTMENT
NATIONAL LAMP WORKS
of General Electric Co.



Drug Store — 15 Foot-Candles



Sheet Metal Stamping — 20 Foot-Candles

The difference between good illumination which cheers the mind and comforts the senses, and poor lighting with its gloom and glare, obviously is nothing more than the difference in results as produced by modern equipment—reflectors and lamps—properly installed, and the results produced by mediocre equipment installed without regard or knowledge of principles and good practice.

ILLUMINATION DESIGN DATA

for
Industrial and Commercial Interiors

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1. Location of Outlets—Adequate Wiring

Lighting standards which we accept today are not only on a better level than those of a few years ago, but studies in light and vision point to even higher standards, which will unquestionably be used in the future.

The wiring plan is the foundation of the lighting system and indeed, is the step that should be given the most careful attention. Because the cost of relighting is made up so largely of wiring costs, it is far more economical, in planning a lighting installation, to provide wiring adequate for future as well as present needs.

When once outlets are properly installed as regards both spacing and size of wire, a change in type of reflector or in size of lamp, may be made without undue complication; but where the spacing of outlets is too great or the wiring inadequate, satisfactory results can never be obtained without extensive alteration.

* * * * * *

The number of outlets to provide for any given area is determined by the maximum allowable spacing between lighting units and is in turn regulated by their height above the floor. The relation between height and spacing is based on the distribution of light to procure a reasonably uniform level of illumination on the working plane. Careful analysis of the accompanying drawings will illustrate the importance of this principle.

Strictly speaking, the spacing for uniform illumination on the work depends upon the height of the light source above the surface to be illuminated, but since most work surfaces are from $2\frac{1}{2}$ to $3\frac{1}{2}$ feet above the floor, the spacing may for practical purposes be considered a function of the mounting height of lamps above the floor. In general, a spacing in feet which does not substantially exceed this mounting height will result in reasonably uniform illumination. See Tables 1 and 2.

When lighting units are mounted as high as the ceiling or roof trusses permit, larger and more efficient lamps may be used, while fewer units—to buy, to install, and to maintain—will be necessary. The ceiling height, or rather the height which units may be mounted clear of obstructions, therefore dictates the maximum permissible spacing.

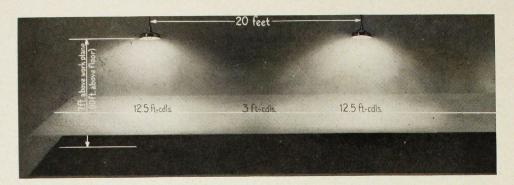


Fig. 1—Units spaced too far apart for their height furnish very uneven illumination, in this case a 4 to 1 variation, and work positions midway between units will be inadequately lighted; harsh shadows will also result. The remedy is to mount the units higher, or if that is impossible, to space them closer as shown in Fig. 2.

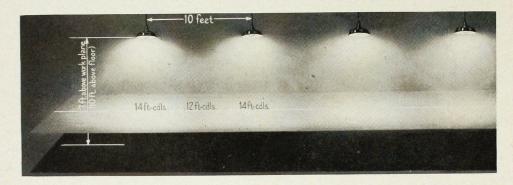


Fig. 2—It will be noted that if the permissible ratio between spacing and mounting height is not exceeded, uniform illumination will be produced. Note also the overlapping of light which serves to eliminate shadows as the units are brought closer together.

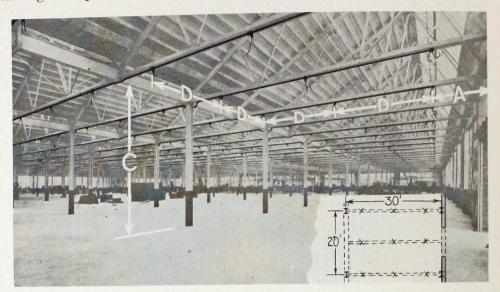
With a light source only 8 feet above the floor one unit would be required for each 55 square feet to give reasonably uniform coverage; for a 10-foot height a unit for each 125 square feet; 15-foot height, 325 square feet; 20-foot height, 650 square feet, etc.

The arrangement of bays, columns, positions of work, however, often suggests a closer spacing to conform to a symmetrical layout, or a more favorable location with respect to work positions where these are known in advance.

Specific data and typical layouts follow.

Spacing of Outlets

The location of outlets is determined by the structural features of the interior—in fact in many cases, particularly in new buildings, the wiring is installed even before the type of lighting unit is decided upon. The ceiling height therefore automatically regulates the maximum permissible spacing, assuming the units are mounted as high as possible.



The layout of lighting outlets for a large industrial building, indicating the application of data in the table below. The 13-foot clearance allows a spacing of 13 feet. For a symmetrical layout in the bays a 10-foot spacing is adopted.

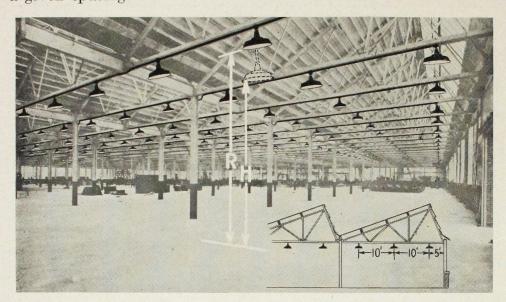
TABLE 1—SPACING OF OUTLETS

Ceiling Height	Spacing Bety	veen Outlets	Spacing Bety Outlets a	Approximate Area per	
(Or Height in the Clear)	Usual (D)	Maximum (For Units at Ceiling) (D)	Aisles or Storage Next to Wall (A)	Desks, Work- benches, etc., Against Wall (B)	Outlet (At Usual Spacings)
(Feet)	(Feet)	Not more than*		Not more than*	
8 9	7 8	$\frac{71/_{2}}{8}$	Usually	3 3	50-60 60-70
10	9	9	one-	31/2	70-85
11 12	$\frac{10}{10-12}$	$\frac{10\frac{1}{2}}{12}$		$\frac{3\frac{1}{2}}{3\frac{1}{2}-4}$	85-100 $100-150$
13	10-12	13	half	$\frac{3\frac{1}{2}-4\frac{1}{2}}{3}$	100-150
14 15	10-13	15	actual	4-5 4-5	$100-170 \\ 100-170$
16	10-13 $10-13$	17 19	spacing	4-6	100-170
18	10-20	21		4-6	100-400
$\frac{20}{22}$	$ \begin{array}{c c} 18-24 \\ 20-25 \end{array} $	24 27	between	5-7 5-7	300-500 400-600
24	20-30	30	units	6-8	400-900
26 30 and up	25-30 $25-30$	33 40		8-9 8-10	600-900 600-900

^{*} Where it is definitely known that some form of indirect lighting will be used, the maximum spacing between outlets may be increased about two feet, and the distance from the outside outlets to the wall may be increased by one foot.

Mounting Height of Lighting Units

When units are spaced less than the maximum permissible distance, they may be dropped from the ceiling for reasons of appearance, ease of cleaning, etc., but in no case should they be dropped below the minimum value shown in column (H) for a given spacing.

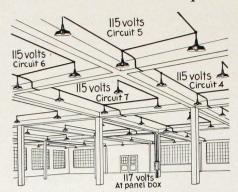


For a 10-foot spacing the units might be dropped to 10 feet above the floor as shown by the dotted outline of a reflector at height H. They are, however, mounted on the trusses 12 feet to minimize glare.

TABLE 2-MOUNTING HEIGHT OF LIGHTING UNITS

		SEMI-INDIRECT AND INDIRECT LIGHTING			
Actual Spacing Between Units	Distance of Units from Floor Not Less Than (H)	Desirable Mounting Height in Industrial Interiors (R)	Desirable Mounting Height in Commercial Interiors (R)	Actual Spacing Between Units	Recommended Suspension Length (Top of Bowl to Ceiling) (S)
(Feet) 7 8 9 10 11 12 14 16 18 20 22 24 26 28 30	$ \begin{array}{c} \text{(Feet)} \\ 8 \\ 8^{1/2} \\ 9 \\ \hline 10 \\ 10^{1/2} \\ 11 \\ \hline 12^{1/2} \\ 14 \\ 15 \\ \hline 16 \\ 18 \\ 20 \\ \hline 21 \\ 22 \\ 24 \\ \end{array} $	12 feet above floor if possible—to avoid glare, and still be within reach from stepladder for cleaning. Where units are to be mounted much more than 12 feet it is usually desirable to mount the units at ceiling or on roof trusses.	The actual hanging height should be governed largely by general appearance, but particularly in offices and drafting rooms, the minimum values shown in Column H should not be violated.	(Feet) 7 8 9 10 11 12 14 16 18 20 22 24 26 28 30	

Adequate-Wiring Data



The Underwriters' Code merely specifies wiring conditions with regard to fire hazard without giving consideration to the economy of operation. The size of wire for a lighting installation may conform strictly to the code and at the same time the circuits be of such length to cause excessive voltage drop. Inadequate wiring is directly responsible for the avoidable waste of electrical energy in overloaded circuits and results in low efficiency of lamps and unsatisfactory lighting conditions.

Wattage Capacity per Outlet—Number of Outlets per Circuit—In order that a higher wattage lamp may be used in each outlet at any future date without necessitating a rearrangement of circuits, it is recommended that the capacity per outlet as given in Table 3 be allowed, and, in general, the number of outlets per circuit as follows: where the capacity is 300 watts or less, not more than 8 per circuit; where 300 to 750 watts per outlet is specified, not more than 4 per circuit; where more than 800 watts per outlet is specified, not over two should be on each circuit.

TABLE 3
ARCHITECTS' AND ELECTRICAL CONTRACTORS' WIRING GUIDE

(See Table 4 for Wire Size)

Actual Floor Area per Outlet	CLASS A INSTALLATIONS (Such as Offices, Drafting Rooms, Factories, etc.)	CLASS B INSTALLATIONS (Such as Stores, School Rooms)	CLASS C INSTALLATIONS (Such as Neighbor- hood Stores, Storage Areas in Factories* and Basements)	CLASS D INSTALLATIONS (Such as Storage Areas in Garages and Unimportant Basements)
Square Feet	Wattage Capacity per Outlet	Wattage Capacity per Outlet	Wattage Capacity per Outlet	Wattage Capacity per Outlet
65-75	300	200	150	100
75-85	300	250	150	100
85–95	350	250	200	100
95-110	400	300	200	100
110-125	450	350	250	150
125-140	500	400	250	150
140-160	600	450	300	150
160-190	700	500	350	200
190-220	800	600	400	200
220-260	950	700	450	250
260-300	1100	800	550	300
300-340	1250	950	650	300
340-390	1450	1100	750	350
390-440	1650	1250	850	400
440-500		1400	950	450
500-560		1600	1050	500
560-630		1800	1200	550
630-710			1350	650
710-800			1500	750
800-900			1700	850

^{*} In factories it is often desirable to convert storage areas into work places to meet immediate production needs. For this reason, it is recommended that storage areas be wired according to Class B specifications.

Voltage Drop—Wire sizes for all classes of lighting installations should be such that the voltage drop between the *panel box* and *outlets* does not exceed 2 volts, computed for each length of run and for an allowance in capacity per outlet as given in Table 3. Table 4 shows the wire size required for various conditions.

TABLE 4—WIRE SIZE REQUIRED

(Length of wire for a circuit is double the length of run)

WATTS PER CIRCUIT

_	- 1	_		-1	-1		01	01	0	01	01	0	6	0	0	0	0	0	0	0	0	0	0
		100	150	200	300	400	200	009	100	800	006	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000	3200
	30	14	14	1 A e diffe	u				14	14	14	14	14	14	12	12	12	12	10	10	10	10	10
	40	14	wirin	g wit	h No	. 12 i	instea	ad of	14	14	14	14	12	12	12	10	10	10	10	10	8	8	8
			vanta	4 is sages	gener	ally	suffic	ient,		-					10	10	10	10	0	8	8	8	8
	50	14	that	mar fy No	y el	ectr	ical	men	14	14	12	12	12	12	10	10	10	10	8	0	°	0	
	60	14	size f	or br	anch	circu	iits.		14	12	12	12	10	10	10	10	8	8	8	8	8	6	6
	70	14	14	14	14	14	14	14	12	12	12	12	10	10	8	8	8	8	8	6	6	6	6
T)	80	14	14	14	14	14	14	12	12	12	10	10	10	8	8	8	8	8	6	6	6	6	6
OUTLET	90	14	14	14	14	14	12	12	12	10	10	10	10	8	8	8	6	6	6	6	6	6	4
OU	100	14	14	14	14	14	12	12	12	10	10	10	8	8	8	6	6	6	6	6	6	4	4
TO	110	14	14	14	14	14	12	12	10	10	10	10	8	8	8	6	6	6	6	4	4	4	4
X	120	14	14	14	14	12	12	10	10	10	10	8	8	8	6	6	6	6	4	4	4	4	4
BC.	130	14	14	14	14	12	12	10	10	10	8	8	8	6	6	6	6	4	4	4	4	4	4
PANEL BOX	140	14	14	14	14	12	12	10	10	8	8	8	8	6	6	6	6	4	4	4	4	4	4
(PA	150	14	14	14	12	12	10	10	10	8	8	8	6	6	6	6	4	4	4	4	4	4	2
NO	160	14	14	14	12	12	10	10	8	8	8	8	6	6	6	4	4	4	4	4	4	2	2
F	170	14	14	14	12	12	10	10	8	8	8	8	6	_ T	his ta	able s	hows	the v	vire s	ize re	quire	2	2
0	180	14	14	14	12	10	10	10	8	8	8	6	6	for :	115-v	olt ci	rcuit	s of v	ariou	s len	gths	of o	2
GTH	190	14	14	14	12	10	10	8	8	8	8	6	6	twe	en th	e par	nel bo	pard bra	and nch	the o	utlet its, a	s. at 2	2
LENGTH OF RUN	200	14	14	14	12	10	10	8	8	8	6	6	6	larg	er th	an N	lo. 8	wire	bec	ause	of th	ne 2	2
	210	14	14	14	12	10	10	8	8	8	6	6	6	the	prop	er wi	re si	ze' for	rap	ropos	sed in	1- 0	2
	220	14	14	14	12	10	10	8	8	8	6	6	6	larg	er th	an No	o. 8, i	t is us	sually	best	eithe	er	2
					4						1			or to	o relo	cate ngths	distr of r	ibutio un.	on ce The	nters dotte	to de	e- ie 9	1
	230	14	14	12	12	10	8	8	8	6	6	6	-	show	vs th	e usu and	al pr	actic	al lin			r- 2	
	240	14	14	12	10	10	8	8	8	6	6	6	4	1	"	*	1 4	1 -	-	1 -	1-	1	1
	250	14	14	12	10	10	8	8	8	6	6	6	4	4	4	4	2	2	2	2	2	1	1

Note—These recommendations on wiring are based on the allowances of The National Code: i. e. circuits equipped with medium screw sockets limited to 15 amperes and not more than 12 outlets per circuit; mogul sockets—limited to 40 amperes and 8 outlets per circuit. Present wiring practice is usually well within the limit allowed by the code. In some cases it is necessary to meet other requirements of local codes.

2. Foot-Candles Required



10,000 Foot-Candles (Outdoors in Sun)



1000 Foot-Candles (Outdoors in shade)



100 Foot-Candles (Daylight near windows)



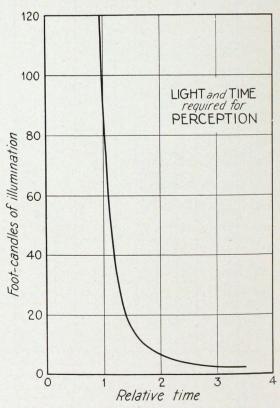
10 Foot-Candles (Artificial light—modern system)



1 Foot-Candle (Artificial light—old style system)

Foot-candle recommendations are based on research studies of vision, on observations of results in actual installations and, furthermore, on the adequacy of present equipment and methods to provide the desirable standard of illumination with safety and economy. All laboratory data point to the desirability of higher levels of illumination from the standpoint of vision, and practical tests substantiate the economy which results because of increased production, fewer accidents, and similar benefits.

But without regard to such factors which are basic considerations of lighting economics, because of the progress the electric industry has made, tending to lower costs of energy and lamps, 30 footcandles cost no more today than 3 foot-candles cost twenty-five years ago.



The eye functions over wide range lighting conditions as illustrated by the photographs at the left; the graph at the right is the scientist's quantitative statement of what everybody has experienced, namely, the eye sees more and sees more quickly as the illumination level is increased.

The foot-candle values given in the following pages correspond to present standards for different classes of industrial operations, offices, stores, etc. They are merely an index to good practice. In most cases, where higher foot-candle values than shown in this table are being used, it is found that the benefits derived more than offset the slightly increased cost. The desirable illumination for any particular installation depends upon actual conditions, such as the accuracy of the operation, the fineness of detail to be observed, the color of the goods worked on or handled, and, in the case of stores, the advertising value resulting from the attractiveness of a well-lighted interior.

TABLE No. 5
Present Standards of Foot-Candles of Illumination for COMMERCIAL INTERIORS

	Foot-Ca Recomn			Foot-Ca Recomm	
	Good Practice	Mini- mum		Good Practice	Mini- mum
Armories: Drill Sheds Exhibition Halls	10 12	6 8	Dance Halls Dental Offices: Waiting Room	6	4
Art Galleries: General On Paintings	5 25-100	3 10	Operating Office	12 50 8	8 25 5
Auditoriums	5	3	Drafting Room	25	15
Automobile Show Rooms	15	10		2.5	13
Bank: Lobby Cages and Offices	10 15	6 10	Elevators: Freight and Passenger Fire Engine House:	6	4
Barber Shop	15	10	When Alarm is turned in	8	5
Base Ball—Indoor Game	15	10	At Other Times	3	2
Basket Ball	15	10	Garage—Automobiles:		0
Bowling: On Alley, Runway and Seats On Pins	8 25	5 15	Storage—Dead	3 8 15	2 5 10
Billiards—General On Table	6 25	4 15	Gymnasiums: Main Exercising Floor Swimming Pool Shower Rooms	12 8 6	8 5 4
Cars: Baggage, Day Coach, Din- ing, Pullman Mail:	8	5	Locker Rooms Fencing, Boxing, Wrestling	6 12	8
Bag Racks Letter Cases	12 15	8 10	Halls, Passageways in Interiors	3	2
StorageStreet Railway and Subway	6 10	4	Handball Hospitals:	25	15
Churches: Auditorium Sunday School Room Pulpit or Rostrum Art Glass Windows	3 8 12 25-50	2 5 8 15	Lobby and Reception Room Corridors	6 3 5	4 2 3
Club Rooms: Lounge Reading Room	5 12	3 8	Private Rooms Night Illumination Operating Table Operating Room	8 0.2 100-200 15	5 0.1 75 10
Court Rooms	10	6	Laboratories	15	10

TABLE No. 5 (Continued)

Present Standards of Foot-Candles of Illumination for COMMERCIAL INTERIORS (Continued)

	Foot-Ca			Foot-Ca Recomm	
	Good Practice	Mini- mum		Good Practice (Two to	Mini- mum
Hotels: Lobby	8	5	Show Cases	times to	hat of
Dining Room	6	4	Show Windows:	(store pre	per
Kitchen	10	6 5	Large Cities—		
Bed Rooms	3	2	Brightly Lighted District.	150	100
Writing Room	12	8	Secondary Business Loca-	75	50
			Neighborhood Stores	50	30
Library: Reading Rooms	12	8	Medium Cities—		
Stack Room	6	4	Brightly Lighted District.	75	50
Lodge Rooms	6	4	Neighborhood Stores	50 50	30 30
	12	8	Small Cities and Towns Lighting to Reduce Day-	30	30
Lunch Room			light Window Reflections.	200-1000	
Market	12	8	Stores-Department and		
Moving Picture Theatre:	5	3	Large Specialty: Main Floors	15	10
During Intermission During Pictures	3	0.1	Other Floors	12	8
			Basement Store	15	10
Museum:	8	5	Stores-Medium Size:		
General Special Exhibits	25-100	10	Art	12	8
			Automobile Supply	12	8
Office Buildings: Private and General Offices-			Bake Shop	12 12	8
Close Work	15	10	Book China	12	8
No Close Work	10	8	Cigar	15	10
File Room	6	4	Clothing	15	10
Vault	6	4 4	Confectionery Dairy Products	12 12	8
	· ·		Decorator	12	8
Post Office:	10	-	Drug	15	10
Lobby Sorting, Mailing, etc	10 15	$\begin{array}{c} 6 \\ 10 \end{array}$	Dry Goods	15 15	10 10
Storage	10	6	Electrical Supply Florist	12	8
Private and General Offices	* 15	10	Furrier	15	10
File Room and Vault	6 3	$\frac{4}{2}$	Grocery	12	8 10
Corridors and Stairways	J	2	Haberdashery	15 12	8
Railway:		-	Hat	15	10
Depot—Waiting Room Ticket Offices	8 12	5 8	Jewelry	15	10
Rest Room, Smoking Room	8	5	Leather, Handbags and	12	. 8
Baggage Checking Office	12	8	Trunks	12	8
Storage Concourse	6	4 4	Millinery	15	10
Train Platform	4	2	Music Notions	12 12	8
Restaurants	8	5	Piano	12	8
Racquet	25	15	Shoe	15 12	10
Schools:			Sporting Goods Tailor	15	10
Auditorium	8	5	Tobacco	15	10
Class Rooms, Library and			Variety Store	15	10
Office	12	8	Telephone Exchanges:	0	5
Corridors and Stairways Drawing	$\frac{5}{25}$	3 15	Operating Rooms Terminal Rooms	8 12	8
Laboratories	12	8	Cable Vaults	6	4
Manual Training	12	8	Tennis (Indoor)	25-50	15
Sewing Rooms Study Room—Desks and	25	15	Theatres:		
Blackboards	12	8	Auditorium	3	2 5
Skating Rink (Indoor)	8	5	Foyer	8	5 8
Squash	25	15	Lobby Toilet and Washrooms	12 6	4
	-0	10	Tonet and Trasmoonis		

TABLE No. 5 (Continued)

Present Standards of Foot-Candles of Illumination for INDUSTRIAL INTERIORS

	Foot-Ca Recomm			Foot-Ca Recomm	
	Good Practice	Mini- mum		Good Practice	Mini- mum
Aisles, Stairways, Passage- ways	3	2	Construction— Indoor General	5	3
Assembling:			Dairy Products	12	8
Rough Medium	8 12	5 8	Electric Manufacturing: Storage Battery, Molding		
FineExtra Fine	20 50-100	12 25	of Grids, Charging Room Coil and Armature Wind-	10	6
Automobile Manufacturing:			ing, Mica Working, Insulating Processes	20	12
Automatic Screw Machines	15	10	Elevator-Freight and Pas-		
Assembly Line Frame Assembly	15 12	10 8	senger	8	5
Tool Making	20	12	Engraving	50-100	25
Body Manufacturing— Assembly, Finishing and			Forge Shops and Welding	10	6
Inspecting	50-100	25	Foundries:		
D.Li	12	8	Charging Floor, Tumbling,		
Bakeries	12		Cleaning, Pouring and Shaking Out	8	5
Book Binding:			Rough Molding and Core Making	10	6
Folding, Assembling, Pasting, etc.	8	5	Fine Molding and Core	10	0
Cutting, Punching and	10	0	Making	15	10
Stitching Embossing	12 15	8 10	Garage—Automobiles: Storage—Dead	3	2
Candy Making	12	8	Live	8	5
Canning and Preserving	12	8	Repair Dept. and Washing	15	10
			Glass Works:		
Chemical Works:			Mix and Furnace Rooms, Pressing and Lehr, Glass		
Hand Furnaces, Boiling Tanks, Stationary Driers,			Blowing Machines	10	6
Stationary or Gravity Crys-			Grinding, Cutting Glass to Size, Silvering	12	8
tallizing	5	3	Fine Grinding, Polishing,		
erators and Stills, Mechan-			Beveling, Inspection, Etching and Decorating	15	10
ical Driers, Evaporators, Filtration, Mechanical			Glass Cutting (Cut Glass),	13	10
Crystallizing, Bleaching	6	4	Inspecting Fine	25-50	15
Tanks for Cooking, Extractors, Percolators, Ni-			Glove Manufacturing:		
tractors, Percolators, Nitrators, Electrolytic Cells.	10	6	Light Goods— Cutting, Pressing, Knitting	12	8
Clay Products and Cements:			Sorting, Stitching, Trimming and Inspecting	15	10
Grinding, Filter Presses, Kiln Rooms	5	3	Dark Goods— Cutting, Pressing, Knitting	15	10
Molding, Pressing, Cleaning and Trimming	8	5	Sorting, Stitching, Trim-	50-100	25
Enameling	10	6	ming and Inspecting	30-100	23
Color and Glazing	15	10	Hat Manufacturing: Dyeing, Stiffening, Braid-		
Cloth Products:			ing, Cleaning and Refin-		
Cutting, Inspecting, Sew-			ing— Light	10	6
Light Goods	15	10	Dark	15	10
Dark Goods	50-100	25	Forming, Sizing, Pouncing, Flanging, Finishing, Iron-		
Pressing, Cloth Treating (Oil Cloth, etc.)—			ing—		
Light Goods	12	8	Light	12 15	8
Dark Goods	20	12	Dark Sewing—		
Coal Breaking and Washing, Screening	5	3	Light Dark	15 50–100	10 25

TABLE No. 5 (Continued)

Present Standards of Foot-Candles of Illumination for INDUSTRIAL INTERIORS (Continued)

	Foot-Ca Recomm	indles iended		Foot-Ca Recomm	
	Good Practice	Mini- mum		Good Practice	Mini- mum
Ice Making: Engine and Compressor Room	10	6	Milling—Grain Foods: Cleaning, Grinding and Rolling Baking or Roasting Flour Grading	8 12 25	5 8 15
Inspecting: Rough Medium Fine Extra Fine	10 15 25 50–100 (Usually glint re	6 10 15 25 requires flections	Offices: Private and General— Close Work No Close Work Drafting Room	15 10 25	10 8 15
Polished Surfaces	from s located source	pecially	Packing: Crating Boxing	6 10	4 6
Jewelry and Watch Manufacturing	50-100	25	Paint Manufacturing Paint Shops:	10	6
Laundries and Dry Cleaning	12	8	Dipping, Spraying, Firing. Rubbing, Ordinary Hand	8 12	5 8
Leather Manufacturing:	5	3	Painting and Finishing Fine Hand Painting and Finishing	15	10
Cleaning, Tanning and Stretching	6 10	4	Extra Fine Hand Painting and Finishing (Automobile Bodies, Piano Cases, etc.)	50-100	25
ing Finishing and Scarfing Leather Working: Pressing, Winding and	15	10	Paper Box Manufacturing: Light Dark Storage of Stock	10 12 5	6 8 3
Glazing— Light Dark Grading, Matching, Cut-	12 15	8 10	Paper Manufacturing: Beaters, Machine, Grinding Calendering Finishing, Cutting and	6 10	4 6
ting, Scarfing, Sewing— Light Dark	15 50–100	10 25	Trimming	12	8 5
Locker Rooms	6	4	Polishing and Burnishing	12	8
Machine Shops: Rough Bench and Machine Work Medium Bench and Ma- chine Work, Ordinary Auto matic Machines, Rough Grinding, Medium Buffing	10	6	Power Plants, Engine Rooms, Boilers: Boilers, Coal and Ash Handling, Storage Battery Rooms	5 8	3 5
and Polishing	15	10	Switchboard, Engines, Generators, Blowers, Compressors	10	6
chines, Medium Grinding Fine Buffing and Polishing Extra Fine Bench and Ma- chine Work, Grinding (Fine	20	12	Printing Industries: Matrixing and Casting, Miscellaneous Machines,		
Work)		25	Presses Proof Reading, Lithographing, Electrotyping	12	8
Meat Packing: SlaughteringCleaning, Cutting, Cook	8	5	Linotype, Monotype, Type- setting, Imposing Stone, Engraving		25
ing, Grinding, Canning Packing	,	8	Receiving and Shipping	6	4

TABLE No. 5 (Continued)

Present Standards of Foot-Candles of Illumination for INDUSTRIAL INTERIORS (Continued)

	Foot-Ca Recomm			Foot-Ca Recomn	
	Good Practice	Mini- mum		Good Practice	Mini- mum
Rubber Manufacturing and Products:			Store and Stock Rooms: Rough bulky material	3	2
Calendars, Compounding Mills, Fabric Preparation, Stock Cutting, Tubing Ma-			Medium or fine material requiring care	8	.5
chines, Solid Tire Opera- tions, Mechanical Goods			Structural Steel Fabrication	10	6
Building, Vulcanizing Bead Building, Pneumatic	12	8	Sugar Grading Testing:	25	15
Tire Building and Finishing, Inner Tube Operation,			Rough	8	5
Mechanical Goods Trimming, Treading	15	10	Fine	15	10
Sheet Metal Works:			Scales, etc	50-100	25
Miscellaneous Machines,			Textile Mills:		
Ordinary Bench Work Punches, Presses, Shears,	12	8	(Cotton)— Opening and Lapping,		
Stamps, Welders, Spinning,	15	10	Carding, Drawing-frame, Roving, Dyeing	8	5
Fine Bench Work Tin Plate Inspection Shoe Manufacturing:	25	15	Spooling, Spinning, Drawing-in, Warping, Weaving, Quilling, Inspecting, Knit-		
Hand Turning, Miscella- neous Bench and Machine	10	o	ting, Slashing (over beam end)(Silk)—	12	8
Work	12	8	Winding, Throwing, Dyeing	12	8
and Welting (Light) Inspecting and Sorting Raw Material, Cutting, Stitch- ing (Dark)	15 50–100	10 25	ing and Finishing— Light Goods Dark Goods	15 20	10 15
Soap Manufacturing:	30 100	2.0	(Woolen)— Carding, Picking, Washing	6	4
Kettle Houses, Cutting,			and Combing Twisting and Dyeing	10	6
Soap Chip and Powder Stamping, Wrapping and Packing, Filling and Pack-	8	5	Drawing-in, Warping— Light Goods Dark Goods	10 15	6 10
ing Soap Powder	10	6	Weaving— Light Goods	12	8
Steel and Iron Mills, Bar, Sheet and Wire Products:			Dark Goods Knitting Machines	20 15	12 10
Soaking Pits and Reheating Furnaces	3	2	Tobacco Products:		0
Charging and Casting	6	4	Drying, Stripping, General Grading and Sorting	3 25	2 15
Muck and Heavy Rolling, Shearing, rough by gauge,			Toilet and Wash Rooms	6	4
Pickling and Cleaning	8	5 15	Upholstering:		
Plate Inspection, Chipping Automatic Machines, Red Light and Cold Rolling Wire Drawing, Sheering		13	Automobile, Coach and Furniture	15	10
Wire Drawing, Sheering fine by line		8	Warehouse	3	2
Stone Crushing and Screening			Woodworking: Rough Sawing and Bench		
Belt Conveyor Tubes Main Line Shafting	,		Work	8	5
Spaces, Chute Rooms, Inside of Bins		2	Sanding, Medium Machine and Bench Work, Gluing,		
Primary Breaker Room Auxiliary Breakers under	,		Veneering, Cooperage Fine Bench and Machine Working, Fine Sanding and	12	8
Bins Screen Rooms		3 5	Finish		10

TABLE No. 5 (Continued)

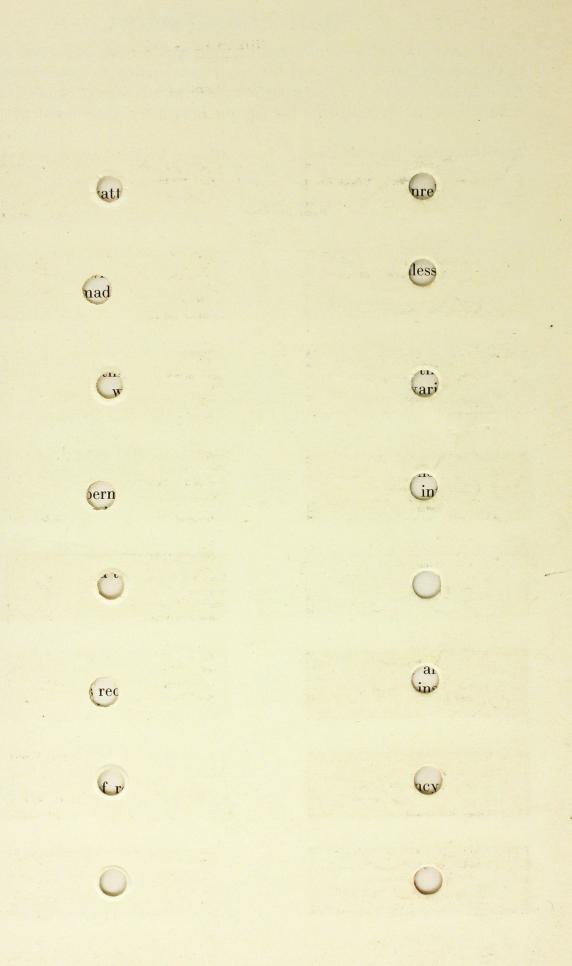
Foot-Candles Illumination for OUTDOOR LIGHTING

These values are included for reference purposes although the special considerations of design are not covered in this bulletin.

	Foot-Candles Recommended			Foot-Ca Recomn	
	Good Practice	Mini- mum		Good Practice	Mini- mum
Automobile Parking Spaces.	1	0.5	Gasoline Filling Stations: At Pumps Yard and Driveways	15 4	$\begin{array}{c} 10 \\ 2 \end{array}$
Baseball Diamond (Indoor Game)	10	6	Horseshoe Pitching	6	4
Basket Ball	6	4	Ice Hockey	8	5
Bathing Beaches	1	0.5	Loading Docks	3	2
Bulletin and Poster Boards:			Lumber Yards	1	0.5
Bright Surroundings—			Motordromes:		
	30	20	Seating	3	2
Light Surface	50	30	Track	15	10
Dark Surroundings—			Monuments (See Building		
Light Surface	15	10	Exteriors)		
Dark Surface	30	20	Piers: Freight (See Loading		
Boxing:	3	2	Docks)		
Seats	80	50	Passenger	4	2
Building:	•		Playgrounds	4	2
Construction Work	6 2	4	Polo	8	5
Excavation	2	1	Prison Yards	3	2
Building Exteriors and Mon-			Protective Industrial	1	0.5
uments—Floodlighted:			Quarries	3	2
Bright Surroundings— Light Surface	10	6	Railway Yards:		
Dark Surface	20	15	General	0.25	$0.15 \\ 2$
Dark Surroundings—			Scale House	3	4
Light Surface	6	4	Roque	6	4
Dark Surface	12	8	Signs—Painted (See Poster		
Church Windows (Art Glass)	25-50	15	Boards)	6	4
Circus:	3	2	Ship Yard Construction	2	1
Seats	10	6	Skating	1	0.5
Clock Golf	10	6	Storage Yards	5	3
Croquet	6	4	Swimming Pools	20	15
Dredging	2	1	Target Shooting		15
Drill Fields	3	2	Tennis Court	25-50	
Flags—Floodlighted	25-50	15	Toboggan Slides	2	1
Football:	20 00	10	Traffic Officers	20	10
Practice	6	4	Trap Shooting	15	10
Games	12	8	Volley Ball	15	10

STREETS AND THOROUGHFARES

	Lamp Lumens per Linear Foot of Street
Business District:	
White Way—Large City	500-2000
Small City	200 500
Park Boulevards	700
Thoroughfares and Wholesale Districts	50-200
Residence Streets	20 10
Outlying Districts and Alleys	- 70
Highways.	70 00



Reflection Factors

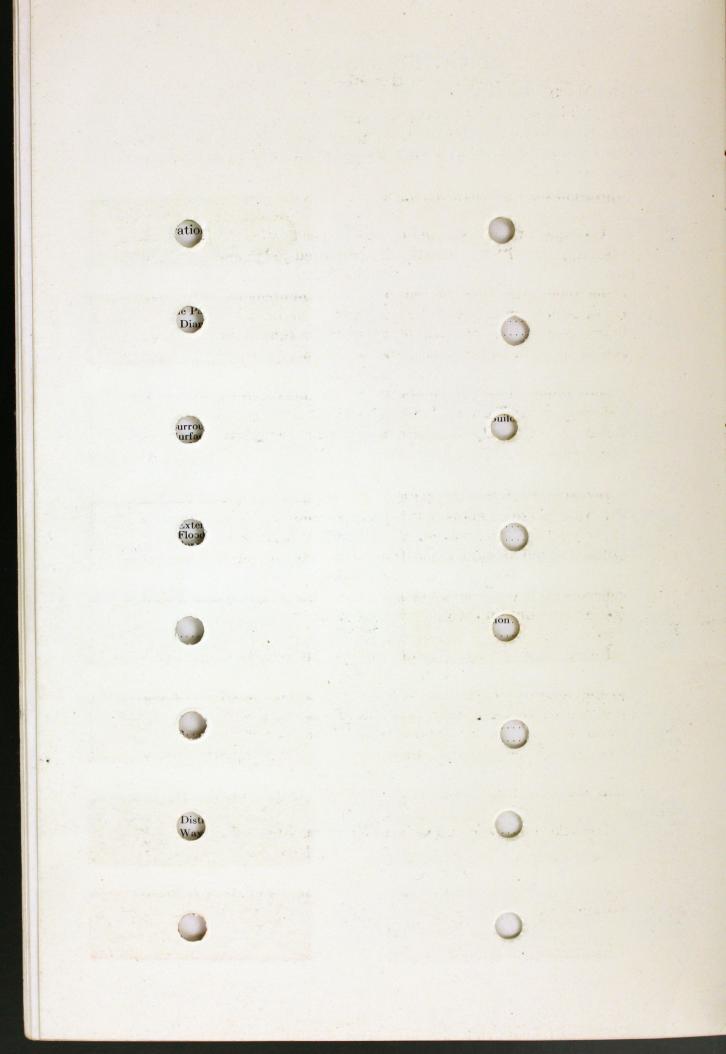
The proportion of light reflected by walls and ceilings of various colors, that is, their Reflection Factors, has an important bearing on both the natural and the artificial lighting. The proportion reflected will depend somewhat upon the color of the incident light. The figures here given show what proportion of



of Colored Surfaces

the light of Mazda lamps these painted surfaces reflect. Reflection Factors are of special usefulness in determining the Coefficient of Utilization (ratio of light delivered at the work to total light of lamps) applicable to an interior. The Reflection Factor of any colored surface can be approximated by comparing it with these samples.





3. Room Efficiency and Reflector Characteristics

In order to specify the lamp size necessary to provide the foot-candles desired, the first step is to determine the percentage of light emitted by the lamp that actually gets down and is useful on the working plane. This percentage is called the Coefficient of Utilization for the particular installation.

A simple "watts per square foot" specification is unreliable unless applied with the benefit of experienced judgment of various factors which affect the result. Interior finish, size and proportions of the room, the type of reflector, and maintenance conditions are variables which must be taken into account. Unless due allowance is made for each of these the results vary, in many cases 5 to 1; in other words, the same wattage per square foot might produce 15 foot-candles under certain conditions and only 3 foot-candles under a combination of unfavorable conditions. Coefficient of Utilization Tables, Pages 24 to 29, give the net efficiency result with due regard for the important variables noted below.

Interior Finish—The paint samples show the percentage of light from Mazda Lamps reflected by various colors; the holes in each sample permit convenient comparison with actual interior finishes. It will be noted that the influence of the interior finish is least important with opaque direct lighting reflectors, more pronounced with translucent glass units and a major consideration with semi-indirect and totally indirect luminaires.

Room Proportions (Room Index)—In general, large rooms use light more efficiently than do small rooms because there is less wall area to absorb light in proportion to floor space. Raising the light source tends to increase the proportion of wall area to floor area, thus reducing the relative efficiency of high bay installations. It will be observed that a room 10 feet square with a 10-foot ceiling has a Room Index of 1. Room Index values are computed with a unit room of this character as the basis.

The effect of room proportions on illumination efficiency, and its importance in actual design problems will be noted by comparing the Coefficient of Utilization for example, for a room having a Room Index of 0.6 against one of 5.0, other factors remaining constant.

Reflector Characteristics*—The selection of a suitable type of lighting unit depends not only upon its efficiency, the proper distribution of light and the requirements of the work, but, in the case of indirect units, upon the construction of the room and color of ceiling and walls. Decorative appearance frequently is an important item.

A lighting installation may be judged by seven fundamentals described on page 21, and in Table 7 various lighting units are rated in accordance with these criteria.

$$A + A$$
 Excellent B Good C Fair $A - B +$ Very Good $B - C +$ Unsatisfactory

The relative importance of these ratings should be carefully weighed with respect to the particular application at hand. For instance, in an office the criteria of major importance would rank: (1) Direct Glare, (2) Reflected Glare, (3) Shadows; (4) Illumination on Horizontal. On the other hand, in a foundry with lamps mounted high the order of importance would be: (1) Illumination on Horizontal, (2) Vertical Illumination, (3) Maintenance. A rating of D under Reflected Glare would not disqualify a unit except for use above polished metal or other highly glazed surfaces.

Procedure

To Determine the Coefficient of Utilization for the Installation

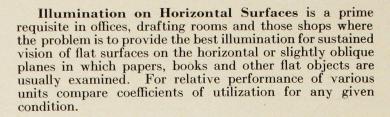
Refer to Table 6—Room Index, which classifies the room according to its proportions. From this table find the Room Index which corresponds most nearly to the dimensions of the installation. Apply this in the use of Table 7.

Refer to Table 7—Coefficients of Utilization, which gives the proportion of the generated light from the lamps which reaches the plane of work. The Coefficient of Utilization for the installation of the type of lighting unit selected will be found in the proper column of wall and ceiling color, opposite the correct Room Index.

^{*}Note: It is important that good reflecting equipment be installed. The luminaires shown in Table 7 illustrate common types under which most reflectors on the market can be classified for purposes of design calculations. For example, No. 8 is a unit of a general type of which there are a great variety made by various manufacturers. Of two or more units of the same type the choice should be governed by considerations of brightness, diffusion, absorption, appearance, and cost, but not by cost alone. Of two samples of glass enclosing globes, outwardly identical, one may absorb 30% of the light and the other only 15% for the same degree of diffusion. The safest plan is to choose products of reliable manufacturers.

ROOM EFFICIENCY AND REFLECTOR CHARACTERISTICS







Illumination on Vertical Surfaces is essential in many industrial operations where working surfaces are in vertical or oblique planes. It is likewise important in stores with vertical shelving, rug racks, etc., in art museums, library stock rooms, office file rooms. Without supplementary units, the illumination on vertical surfaces from ordinary general lighting units is of the order of one-half to one-third of the horizontal illumination values.



Appearance of Lighted Room refers only to the general or casual effect produced by the complete system, and is not intended to rate the unit as to satisfaction from the standpoint of good vision or freedom from eye fatigue.



Direct Glare is the most frequent and serious cause of bad lighting. It results among other things from unshaded or inadequately shaded light sources located within the field of vision, or from too great contrast between the bright light source and a dark background or adjacent surfaces. Glare should be avoided by the use of proper reflecting and diffusing equipment.



Reflected Glare from polished working surfaces is particularly annoying because of the necessity of directing the eyes toward those surfaces, and further because the eyes are by nature especially sensitive to light rays from below. The harmful effects of this specular reflection can be minimized by properly shielding from below or diffusing the source.



Shadows, that is, differences in brightness of surfaces, are essential in observing objects in their three dimensions, but are of little or no value in the observation of flat surfaces. Where shadows are desirable, they should be soft and luminous, not so sharp and dense as to confuse the object with its shadow.



Maintenance Requirements depend upon contour of reflector, construction of fixture, and average maintenance conditions. The rating is based upon the likelihood of breakage, the labor invoved in maintaining the units at comparable degrees of efficiency, and indication given of need of cleaning.

ROOM EFFICIENCY AND REFLECTOR CHARACTERISTICS

TABLE 6
ROOM INDEX FOR NARROW AND AVERAGE ROOMS

					FEET			
For Indirect Use Ceiling	Lighting Height	9 and 91/2	10 to 11½	12 to 13½	14 to 16½	17 to 20	21 to 24	25 to 30
					FEET			
For Direct Use Mountir	Lighting hg Height	7 and 7½	8 and 81/2	9 and 91/2	10 to 11½	12 to 13½	14 to 16½	17 to 20
Room Width (Feet)	Room Length (Feet)			RO	OM INI	EX		
9 (8½-9½)	8-10 10-14 14-20 20-30 30-42 42-up	1.0 1.0 1.2 1.2 1.5 2.0	0.8 0.8 1.0 1.2 1.2 1.5	0.6 0.8 0.8 1.0 1.0	0.6 0.6 0.8 0.8 1.0	0.6 0.6 0.6 0.8	0.6 0.6 0.6	0.6 0.6
$10 \\ (9\frac{1}{2}-10\frac{1}{2})$	10-14 14-20 20-30 30-42 42-60 60-up	1.2 1.2 1.5 1.5 2.0 2.0	1.0 1.0 1.2 1.2 1.5 1.5	0.8 0.8 1.0 1.2 1.2 1.5	0.6 0.8 1.0 1.0	0.6 0.6 0.8 0.8 1.0	0.6 0.6 0.6 0.6 0.8	0.6 0.6 0.6
$\frac{12}{(11-12\frac{1}{2})}$	10-14 14-20 20-30 30-42 42-60 60-up	1.2 1.5 1.5 2.0 2.0 2.0	1.0 1.2 1.2 1.5 1.5 2.0	0.8 1.0 1.2 1.2 1.5 1.5	0.8 0.8 1.0 1.0 1.2 1.2	0.6 0.8 0.8 1.0 1.0	0.6 0.6 0.6 0.6 0.8 0.8	0.6 0.6 0.6 0.6
$14 \ (13-15\frac{1}{2})$	14-20 20-30 30-42 42-60 60-90 90-up	1.5 2.0 2.0 2.0 2.5 2.5	1.2 1.5 1.5 2.0 2.0 2.0	1.0 1.2 1.5 1.5 2.0 2.0	1.0 1.0 1.2 1.5 1.5	0.8 0.8 1.0 1.0 1.2 1.5	0.6 0.6 0.8 0.8 1.0 1.2	0.6 0.6 0.6 0.6 0.6 0.8
$17\\ _{(16\text{-}18\frac{1}{2})}$	14-20 20-30 30-42 42-60 60-110 110-up	2.0 2.0 2.5 2.5 2.5 3.0	1.5 1.5 2.0 2.0 2.0 2.5	1.2 1.5 1.5 2.0 2.0 2.0	1.0 1.2 1.2 1.5 1.5 2.0	0.8 1.0 1.0 1.2 1.2	0.6 0.8 1.0 1.2 1.2 1.2	0.6 0.6 0.6 0.8 0.8 1.0
$20 \ (19-21\frac{1}{2})$	20-30 30-42 42-60 60-90 90-140 140-up	2.5 2.5 2.5 3.0 3.0 3.0	2.0 2.0 2.5 2.5 2.5 2.5 2.5	1.5 2.0 2.0 2.0 2.5 2.5	1.2 1.5 2.0 2.0 2.0 2.0	1.0 1.2 1.5 1.5 1.5 1.5	0.8 1.0 1.2 1.2 1.5 1.5	0.6 0.8 0.8 1.0 1.0
24 (22-26)	20-30 30-42 42-60 60-90 90-140 140-up	2.5 3.0 3.0 3.0 3.0 3.0 3.0	2.0 2.5 2.5 2.5 3.0 3.0	2.0 2.0 2.5 2.5 2.5 2.5 2.5	1.5 1.5 2.0 2.0 2.0 2.0	1.2 1.2 1.5 1.5 2.0 2.0	1.0 1.2 1.2 1.5 1.5 1.5	0.8 0.8 1.0 1.0 1.2 1.2
30 (27-33)	30-42 42-60 60-90 90-140 140-180 180-up	3.0 3.0 4.0 4.0 4.0 4.0	2.5 3.0 3.0 3.0 3.0 3.0	2.5 2.5 3.0 3.0 3.0 3.0	2.0 2.5 2.5 2.5 2.5 2.5 2.5	1.5 1.5 2.0 2.0 2.0 2.0	1.2 1.5 1.5 2.0 2.0 2.0 2.0	1.0 1.0 1.2 1.5 1.5 1.5
36 (34-39)	30-42 42-60 60-90 90-140 140-200 200-up	4.0 4.0 5.0 5.0 5.0 5.0	3.0 3.0 3.0 4.0 4.0 4.0	2.5 3.0 3.0 3.0 3.0 3.0 3.0	2.0 2.5 3.0 3.0 3.0 3.0	1.5 2.0 2.0 2.5 2.5 2.5	1.5 1.5 2.0 2.0 2.0 2.0 2.0	1.0 1.2 1.5 1.5 1.5 1.5
40 or more	42-60 60-90 90-140 140-200 200-up	5.0 5.0 5.0 5.0 5.0	4.0 4.0 4.0 5.0 5.0	3.0 4.0 4.0 4.0 4.0	The		s are give	

ROOM EFFICIENCY AND REFLECTOR CHARACTERISTICS

TABLE 6
ROOM INDEX FOR LARGE HIGH ROOMS

					FE	ET			
For Indirect Use Ceiling	Lighting Height	14 to 16½	17 to 20	21 to 24	25 to 30	31 to 36	37 to 50		
					FE	ET			
For Direct Use Mountin	Lighting hg Height	10 to 11½	12 to 13½	14 to 16½	17 to 20	21 to 24	25 to 30	31 to 36	37 to 50
Room Width (Feet)	Room Length (Feet)					INDEX			
14 (13-151/2)	14-20 20-30 30-42 42-60 60-90 90-up	1.0 1.0 1.2 1.5 1.5	$\begin{array}{c c} 0.8 \\ 0.8 \\ 1.0 \\ 1.0 \\ 1.2 \\ 1.5 \end{array}$	$\begin{array}{ c c c }\hline 0.6 \\ 0.6 \\ 0.8 \\ 0.8 \\ 1.0 \\ 1.2 \\ \end{array}$	0.6 0.6 0.6 0.6 0.6 0.8	0.6 0.6 0.6 0.6	0.6 0.6 0.6		
17 (16-18½)	14-20 20-30 30-42 42-60 60-110 110-up	1.0 1.2 1.2 1.5 1.5 2.0	0.8 1.0 1.0 1.2 1.2 1.5	$\begin{array}{ c c c }\hline 0.6 \\ 0.8 \\ 1.0 \\ 1.2 \\ 1.2 \\ 1.2 \\ \end{array}$	0.6 0.6 0.6 0.8 0.8 1.0	0.6 0.6 0.6 0.8	0.6 0.6 0.6 0.6	0.6 0.6 0.6	
20 (19-21½)	20-30 30-42 42-60 60-90 90-140 140-up	1.2 1.5 2.0 2.0 2.0 2.0	1.0 1.2 1.5 1.5 1.5 1.5	0.8 1.0 1.2 1.2 1.5 1.5	0.6 0.8 0.8 1.0 1.0	0.6 0.6 0.6 0.6 0.8 1.0	0.6 0.6 0.6 0.8 0.8	0.6 0.6 0.6 0.6	0.6
24 (22-26)	20-30 30-42 42-60 60-90 90-140 140-up	$\begin{array}{c c} 1.5 \\ 1.5 \\ 2.0 \\ 2.0 \\ 2.0 \\ 2.0 \end{array}$	1.2 1.2 1.5 1.5 2.0 2.0	1.0 1.2 1.2 1.5 1.5 1.5	0.8 0.8 1.0 1.0 1.2 1.2	0.6 0.6 0.8 0.8 1.0 1.0	0.6 0.6 0.6 0.6 0.8 0.8	0.6 0.6 0.6 0.8	0.6 0.6 0.6
30 (27-33)	30-42 42-60 60-90 90-140 140-180 180-up	2.0 2.5 2.5 2.5 2.5 2.5 2.5 2.5	1.5 1.5 2.0 2.0 2.0 2.0 2.0	1.2 1.5 1.5 2.0 2.0 2.0 2.0	1.0 1.0 1.2 1.5 1.5 1.5	0.8 1.0 1.0 1.2 1.2 1.2	0.6 0.8 0.8 1.0 1.0	0.6 0.6 0.6 0.8 0.8	0.6 0.6 0.6 0.6
36 (34-39)	30-42 42-60 60-90 90-140 140-200 200-up	2.0 2.5 3.0 3.0 3.0 3.0	1.5 2.0 2.0 2.5 2.5 2.5	1.5 1.5 2.0 2.0 2.0 2.0 2.0	1.0 1.2 1.5 1.5 1.5 1.5	0.8 1.0 1.0 1.2 1.5 1.5	0.8 0.8 1.0 1.0 1.2 1.2	0.6 0.6 0.6 0.8 1.0 1.0	0.6 0.6 0.6 0.8 0.8
42 (40-45)	42-60 60-90 90-140 140-200 200-up	3.0 3.0 3.0 3.0 3.0	2.0 2.5 2.5 2.5 2.5 2.5	1.5 2.0 2.5 2.5 2.5 2.5	1.2 1.5 2.0 2.0 2.0	1.0 1.2 1.5 1.5 1.5	0.8 1.0 1.2 1.2 1.5	0.8 0.8 1.0 1.0 1.2	0.6 0.6 0.8 0.8
50 (46-55)	42-60 60-90 90-140 140-200 200-up	3.0 3.0 3.0 3.0 3.0	2.5 3.0 3.0 3.0 3.0 3.0	2.0 2.5 2.5 2.5 2.5 2.5	1.5 1.5 2.0 2.0 2.0	1.2 1.5 1.5 2.0 2.0	1.0 1.2 1.5 1.5 1.5	0.8 1.0 1.2 1.2 1.2	0.6 0.6 0.8 0.8 1.0
60 (56-67)	60-90 90-140 140-200 200-up	4.0 4.0 4.0 4.0	3.0 3.0 3.0 3.0	2.5 3.0 3.0 3.0	2.0 2.5 2.5 2.5 2.5	$ \begin{array}{c c} 1.5 \\ 2.0 \\ 2.0 \\ 2.0 \end{array} $	1.2 1.5 1.5 2.0	1.0 1.2 1.5 1.5	1.0 1.0 1.0
75 (68-90)	60-90 90-140 140-200 200-up	5.0 5.0 5.0 5.0	4.0 4.0 4.0 4.0	3.0 3.0 4.0 4.0	2.5 2.5 3.0 3.0	2.0 2.0 2.5 2.5 2.5	1.5 1.5 2.0 2.0	1.2 1.5 1.5 1.5	0.8 1.0 1.2 1.2
90 or more	60-90	5.0 5.0 5.0 5.0	4.0 5.0 5.0 5.0	3.0 4.0 4.0 4.0	2.5 3.0 3.0 3.0	2.0 2.5 2.5 3.0	1.5 2.0 2.0 2.5	1.2 1.5 1.5 2.0	1.0 1.2 1.2 1.5

TABLE No. 7 A GUIDE TO THE SELECTION OF REFLECTING EQUIPMENT

LIGHTING	UNIT	RELATIVE CANDLES FO LAMP	RAGIVEN	APPEAR- ANCE OF LIGHTED	DIRECT GLARE	RE- FLECTED GLARE	SHADOWS	MAIN- TENANCE
		On Horizontal	On Vertical	ROOM				
	Direct Lightin	ng—Ger	eral Ir	ndustria	l Refle	ctors		
RLM White Bowl Lamp 90° to 180°—0% 0° to 90°—66%		A Excellent	B Good	B Good	B+ Very Good	B Good	B+ Very Good	A — Very Good
2 Glassteel Diffuser Clear Lamp 90° to 180°-7% 0° to 90°-60%		A — Very Good	B Good	A— Very Good	A — Very Good	B+ Very Good	A Excellent	B Good
	$S_{\mathbf{I}}$	oecial R	LM Ap	plicatio	ns			
RLM Dome Dust-tight Cover 90° to 180°—0% 0° to 90°—54%		B Good	B— Very Fair	B Good	B Good	B- Very Fair	B+ Very Good	A+ Excellent
4 RLM Dome Clear Lamp 90° to 180°—0% 0° to 60°—76%		A+ Excellent	B+ Very Good	C+ Very Fair	C Satisfactory above 20-foot mount- ing Height	D Unsatis- factory above Polished Surfaces	C+ Very Fair	A+ Excellent
	Industrial	Reflecto	rs for l	High Na		Bays		
Concentrated Prismatic Reflector Aluminum Cover Clear Lamp 90° to 180°—14% 0° to 90°—65%		A+ Excellent	B Good	B Good	C+ Very Fair	Unsatis- factory above Polished Surfaces	C Fair	A Excellent
Mirrored Glass Reflector Clear Lamp 90° to 180°—0% 0° to 60°—70%		A+ Excellent	B Good	B Good	C+ Very Fair	Unsatis- factory above Polished Surfaces	C Fair	A Excellent
Polished Aluminum Reflector Clear Lamp 90° to 180°—0% 0° to 90°—72%		A+ Excellent	B Good	B Good	C Very Fair	Unsatis- factory above Polished Surfaces	C+ Fair	A — Very Good

TABLE No. 7 AND COEFFICIENTS OF UTILIZATION

PROBABLI	E AVERAGE	ILLUMI-	CEILING	VERY	LIGHT (7	10%)	FAIRLY	LIGHT ((50%)	FAIRLY DA	RK (30 %
OF INIT	IAL ILLUM	INATION	WALLS	FAIRLY LIGHT (50%)	FAIRLY DARK (30%)	VERY DARK (10%)	FAIRLY LIGHT (50%)	FAIRLY DARK (30%)	VERY DARK (10%)	FAIRLY DARK (30%)	VERY DARK (10%)
Clean	Average Conditions	Dirty Conditions	ROOM		COE	FFICIE	ENTS	OF UT	ILIZA	TION	
			Calc	ulatio			eral Ur				
	1		0.6	.32	.28	.25	.32	.28	.25	.27	.25
			0.8 1.0	.40	.36	.34	.39	.35	.33	.35	.33
			1.2 1.5	.46 .48	.43	.41	.45, .47	.43 .45	.41	.43	.41
.80	.75	.65	2.0 2.5	.52 .56	.50	.48 .52	.51 .55	.49	.47 .51	.49	.47
			3.0	.57	.55	.53	.56 .59	.54 .57	.52 .55	.54	.52 .55
			5.0	.61	.59	.57	.60	.58	.57	.58	.56
			0.6	.29	.25	.21	.28	.31	.28	.31	.28
			1.0 1.2	.39	.36	.33	.38	.35	.33	.34	.35
.75	.70	.60	1.5 2.0	.45	.42	.39	.43	.40	.38	.39	.38
			2.5	.53 .54	.50 .52	.47	.51 .52	.49 .50	.47	.47	.46
			4.0 5.0	.57	.55 .56	.53	.55 .56	.53 .54	.51	.51	.50 .51
		C			ata—F	RLM S	pecial	Service	•		
			0.6	.29	.26	.24	.28	.26	.24	.26	.24
			1.0	.37 .40	.36	.35	.37	.35	.34	.35	.34
00	75	.70	1.5	.42	.41	.38	.41	.39	.38	.39	.38
.80	.75	.10	2.0	.48	.45	.44	.46	.45	.44	.44	.44
			3.0	.49 .50 .52	.47 .48 .49	.48	.49	.47	.46	.46	.46
			0.6	.34	.29	.24	1 .34	29	.24	.28	.24
			1.0	.42	.38	.34	.42	.42	.39	.42	.39
			1.2 1.5	.50 .53	.47	.43	.52	.49	.46	.48	.45
.80	.75	.70	2.0 2.5	.58	.55	.51 .56	.57	.54	.51 .56	.53	.51
			3.0 4.0	.64	.61 .65	.58	.63	.60	.58	.60	.58
			5.0	.69	.67	.65 — Hig l	a Bay	Units	.64	.65	.63
			0.6	.40	.37	.36	1 .39	.37	35	38	.34
			0.8 1.0	.48	.46	.45	.46	.45 .48 .52	.44	.44	.42 .46 .48
			1.2	.55 .58	.54 .57	.53 .55	.54 .55	.54	.50 .53	.51	.50
.80	.75	.65	2.0	.61 .65	.60 .62	.58 .61	.59 .62	.58	.56	.56 .58	.52 .55
			3.0	.66	.65 .66	.63 .65	.63	.62	.60	.59	.56
			5.0	.70	.68	.66	.66	.64	.36	.61	.58
			0.6	.48	.46	.45	.47	.45	.44	.45	.43
			1.0 1.2 1.5	.54	.53	.52	.53	.52	.51 .54	.50 .52 .54	.50
.80	.70	.60	2.0	.60	.59	.57	.59	.58	.57 .59	.57 .59	.56
			2.5 3.0	.63	.61	.60	.61	.61	.60	.60	.59
			4.0 5.0	.65	.64	.63	.64	.63	62	.62	.61
			0.6	.41 .49 .52	.39	.37	.40	.39 .47 .51	.37	.47	.50
			1.0	.55	.52	.51 .54	.52 .54	.54	.50 .52 .55	.54	.52
.80	.70	.60	1.5 2.0	.59	.57	.56	.57	.60	.58	.59	.57
.50			2.5	.65	.63 .65	.62	.63	.62	.61	.61 .62	.61 .62
			4.0	.67	.65 .67	.65	.65	.64	.63	.63	.63

TABLE No. 7 (Continued) A GUIDE TO THE SELECTION OF REFLECTING EQUIPMENT

A GUIDE	TO THE SE	RELATIVI						
LIGHTING	UNIT	CANDLES FO	R A GIVEN	APPEAR- ANCE OF LIGHTED	DIRECT GLARE	RE- FLECTED GLARE	SHADOWS	MAIN- TENANCE
		On Horizontal	On Vertical	ROOM		ULAKE		
	Store and	General	Utility	Enclos	ing Un	its		
R Flattened White Glass Enclosing Globe 90° to 180°—35% 0° to 90°—45%		B+ Very Good	B+ Very Good	A Excellent	B Good	B+ Very Good	A — Very Good	B+ Very Good
9 Prismatic Glass Enclosing Unit 90° to 180°—27% 0° to 90°—53%		A — Very Good	B+ Very Good	A Excellent	B Good	B- Very Fair	B Good	B Good
	Enclosed	Semi-Ir	ndirect	Lightin	g Units	S		
Enclosed Semi-Indirect Enameled Bottom Etched Top Skeleton Glass Holder 90° to 180°—50% 0° to 90°—27%		B- Very Fair	B- Very Fair	A Excellent	A — Very Good	B+ Very Good	A - Very Good	B Good
Enclosed Semi-Indirect Enameled Bottom Etched Top 90° to 180°—48% 0° to 90°—32%		B Good	B— Very Fair	A Excellent	A — Very Good	B+ Very Good	A- Very Good	B Good
Enclosed Semi-Indirect Enameled Bottom Etched Top (Close Ceiling Only) 90° to 180°—53% 0° to 90°—22%		B- Very Fair	C+ Very Fair	A Excellent	A Excellent	A — Very Good	A Excellent	B Good
Enclosed Semi-Indirect Cased-Glass Bottom Etched Top 90° to 180°—51% 0° to 90°—21%		C+ Very Fair	C+ Very Fair	A Excellent	A Excellent	A Excellen	A t Excellent	B- Very Fair
Enclosed Semi-Indirect Prismatic Glass 90° to 180°—69% 0° to 90°—17%		B- Very Fair	C+ Very Fair	A Excellent	A Excellent	A Excellen	A t Excellent	B Good

TABLE No. 7 (Continued) AND COEFFICIENTS OF UTILIZATION

PROBABL	E AVERAGI	E ILLUMI-	CEILING	VERY	LIGHT (7	10%)	FAIRLY	LIGHT (50%)	FAIRLY DA	RK (30%
OF INIT	N—AS FRA	INATION	WALLS	FAIRLY LIGHT (50%)	FAIRLY DARK (30%)	VERY DARK (10%)	FAIRLY LIGHT (50%)	FAIRLY DARK (30%)	VERY DARK (10%)	FAIRLY DARK (30%)	VERY DARK (10%)
Clean	Average Condition	Dirty*	ROOM	(/0/			NTS (A CONTRACT OF THE PARTY OF	
Jonattion	Contaction	Containon	INDEX	1						TON.	
			0.6	.22	Data-	- Enc id	osing U	.16	.13	.14	.12
			0.8	.27	.22	.19	.25	.21	.18	.19	.17
			1.2	.35	.30	.26 .29	.31 .34	.27	.24	.25 .27	.22
.80	.75	.65	2.0 2.5	.42 .46	.38	.33 .37	.38 .41	.34	.31 .34	.31	.28
			3.0	.49	.45	.40	.43	.39	.36 .40	.36	.33 .36
			5.0	.55	.51	.47	.49	.45	.17	.40	.38
			0.8	.35	.29	.25	.33	.28	.24	.26	.23
			1.2	.43	.37	.33 .36	.40	.35 .38	.31 .34	.33	.30 .33
.80	.70	.60	2.0 2.5	.51 .55	.46 .51	.42	.47	.43	.40 .44	.40	.38
			3.0	.58	.54 .58	.50 .55	.54 .57	.50	.47	.46 .50	.44
		Calcula	5.0	.65	.61	.57	.60 and I	.56	.53	.52	.50
	1	Laicuia	1 0.6	1.17	.13	1.10	1 .14	.11	.09	1 .08	.07
			0.8	.21	.17	.14	.18	.14	.12	.12	.10
.75	.70		1.2	.28	.23	.20	.23	.19	.17	.16	.14
			2.0 2.5	.35 .38	.30 .34	.27	.29	.25 .28	.22	.20	.18
			3.0 4.0	.41	.37	.33	.34	.30	.27	.25	.22 .25 .27
			1 0.6	.47	.14	.11	.39	.36	.33	1 .10	.08
			1.0	.24	.19	.16	.21	.16 .19 .22	.14 .17 .19	.14 .16 .18	.14
.75	.70		1.2	.30	.25	.22	.26	.25	.22	.20	.18
			2.0	.38	.33	.29	.32 .35 .38	.28 .32 .34	.25 .28 .31	.26	.24
			3.0 4.0 5.0	.44 .49 .51	.40 .44 .47	.36 .40 .43	.41	.37	.35	.31	.29
			0.6	18 .22	.14	.11	1 .15	1.12	1.10	.09	.08
			$\begin{array}{ c c } 0.8 \\ 1.0 \\ 1.2 \\ \end{array}$.25	.21	.19	.21	.18	.16	.15	.12
.75	.70		1.5	.31	.27	.24	.26	.22	.20	.18	.16
			2.5 3.0	.38	.34	.31	.31	.29	.26	.23	.21
			4.0 5.0	.44	.41	.38	.36 .38	.34	.32	.26	.26
			0.6	16 .20	.12	10 .14	13	.10	.08	.08	.07 .09 .11
			1.0	.23	.19	.17	.19	.16	.14 .16 .19	.13 .14 .16	.13
.75	.65		1.5 2.0	.29	.25	.21	.24 .27 .29	.20 .23 .26	.21	.18	.17
			3.0	.35	.31	.28	.31	.28	.26	.20 .22 .24	.21
			5.0	.41	.38	.35	.36	.33	31	26	.24
			0.6	.18	.14 .18 .21	.11 .15 .18	.14 .18 .20	.14	.12	.10	.09
	70		1.0 1.2 1.5	.25 .29 .33	.24	.21	.23	.19	.17	.14	.12
.75	.70		2.0	.36	.32	.28	.29	.25	.22	.18	.16
			2.5 3.0 4.0	.40 .43 .47	.38	.35	.33	.30	.27	.22	.20
4-70			5.0	.49	.45	.39	.37	.36	.33	eiling and	.24

^{*} Semi-indirect and indirect units unsuitable under very dirty conditions or where ceiling and sidewalls are very dark colored.

TABLE No. 7 (Continued) A GUIDE TO THE SELECTION OF REFLECTING EQUIPMENT

LIGHTING L		RELATIVE CANDLES FO LAMP	R A GIVEN	APPEAR- ANCE OF LIGHTED	DIRECT GLARE	RE- FLECTED GLARE	SHADOWS	MAIN- TENANCE
		On Korizontal	On Vertical	ROOM		GLARE		
	Semi-Indire	ect and	Indire	et Ligh	ting Un	iits		
Open Semi-Indirect Enameled Deflector Dense Glass Bottom Plate 90° to 180°—54% 0° to 90°—18%		B- Very Fair	C Fair	A Excellent	A — Very Good	B+ Very Good	A — Very Good	C Fair
16 Enclosed Luminous Bowl Indirect 90° to 180°—64% 0° to 90°—6%		C+ Very Fair	C Fair	A Excellent	$ m A+ \ _{Excellent}$	m A+Excellent	A Excellent	B- Very Fair
17 Open Indirect 90° to 180°—80% 0° to 90°—0%	A	C+ Very Fair	C Fair	B+ Very Good		A+ Excellent	A+ Excellent	C Fair
SI	PECIAL UNIT	rs for	COMM	1ERCIA	L INTI	ERIORS		
Dense White Glass Reflector Frosted Lamp 90° to 180°—12% 0° to 90°—70%		glare and totally er locations of occasion	shadows nclosing w as small onal use w cients of	make the white units rooms, clownhere low	100 wattree open types. Its printers, stockwattage on average	pe unit les ncipal ap k bin aisle lamps are	ss satisfac plication i es, and oth suitable.	tory than s in such ner places
Round and Stalactite Globes 90° to 180°—38% 0° to 90°—42%		improve Flattened and are are, howe including efficient	the distri- l units like usually to ever, appli- certain s distribution cients of	bution of e No. 8 dis o be prefe icable in w tores whe on of light	diffuse the light as stribute light extribute lighter than the lighter tha	obtained the more ealactite and more alactite and most and more an	from a ba fficiently of ad spheric and other is attache	are lamp. lownward cal globes r interiors ed to the
20 Large Opaque Reflector Open Diffusing Bowl 90° to 180°—13% 0° to 90°—60%		reflector freedom dirt colle unit is a spacing h in interior because	render to from glar section it respectively to the petween upors where of unfavoracients of	he unit le and shate tains the for close nits often a indirect rable ceiling.	both the ow in branch shadow disadvant ceiling medical desirable lighting ing finish.	ightness vs. From tage of th counting, in large s is preferre	with correct the stand e open bo permitting tores; it seed but in	dpoint of wl. This a wider erves well appractical
21 Enclosing Unit Large Decorative Shade 90 ° to 180 °—21% 0 ° to 90 °—56%		used as sunits. S themselve effective of the ey stores ar stores.	shades in uch shade es to a v in reducin e, with slind certain Shades ca	connections not only ariety of g the cand ght loss in millinery n be added	other man with end and an edesigns of the designs of the designs of the design of the	closed opallement of stencils, nd brights y. Very sing section fixtu	decoration decoration but they ness in the uitable in ons of decres.	prismatic a, lending are also direction exclusive partment

TABLE No. 7 (Continued) AND COEFFICIENT OF UTILIZATION

PROBA3L	E AVERAGE	ILLUMI-	CEILING	VERY	LIGHT (7	0%)	FAIRLY	LIGHT (50%)	FAIRLY DA	RK(30%)
NATIO	N—AS FRA	NATION	WALLS	FAIRLY LIGHT (50%)	FAIRLY DARK (30%)	VERY DARK (10%)	FAIRLY LIGHT (50%)	FAIRLY DARK (30%)	VERY DARK (10%)	FAIRLY DARK (30%)	VERY DARK (10%)
Clean Condition	Average Condition	Dirty* Condition	ROOM INDEX		COE	FFICIE	ENTS (OF UTI	LIZA	TION	
.70	.60		0.6 0.8 1.0 1.2 1.5 2.0 2.5 3.0 4.0 5.0	.18 .22 .25 .28 .31 .34 .37 .39 .43 .44	.15 .19 .22 .25 .27 .31 .34 .36 .40	.13 .17 .20 .22 .24 .28 .32 .34 .37 .40	.15 .19 .21 .24 .26 .28 .30 .32 .32 .34	.12 .16 .18 .21 .22 .25 .28 .29 .32 .34	.10 .14 .16 .19 .21 .24 .26 .28 .31	.10 .13 .15 .16 .17 .20 .22 .23 .25 .26	.08 .11 .13 .15 .16 .19 .21 .22 .24
.75	.65		0.6 0.8 1.0 1.2 1.5 2.0 2.5 3.0 4.0 5.0	.14 .18 .20 .23 .26 .29 .31 .34 .37	.11 .14 .17 .20 .22 .26 .28 .31 .34	.10 .13 .15 .17 .19 .23 .26 .28 .32 .34	.11 .14 .15 .18 .20 .22 .24 .25 .27	.09 .11 .13 .15 .17 .19 .21 .23 .26 .27	.07 .10 .11 .13 .15 .17 .20 .21 .24 .26	.06 .07 .09 .10 .11 .13 .14 .15 .17	.05 .06 .07 .09 .10 .12 .13 .14 .16
.70	.60		0.6 0.8 1.0 1.2 1.5 2.0 2.5 3.0 4.0 5.0	.15 .18 .22 .25 .27 .30 .34 .36 .40 .42	.12 .15 .19 .22 .24 .27 .31 .33 .37 .39	.10 .13 .16 .19 .21 .25 .28 .30 .34 .37	.11 .13 .15 .18 .20 .22 .24 .26 .28 .30	.09 .11 .13 .15 .17 .19 .22 .24 .26 .28	.07 .09 .11 .13 .15 .17 .20 .22 .24 .26	.05 .07 .08 .09 .10 .11 .13 .14 .15	.04 .06 .07 .08 .09 .10 .12 .13 .14

SPECIAL UNITS FOR COMMERCIAL INTERIORS

22

Enclosed Semi-Indirect Enameled Deflector Etched Glass Top

90° to 180°—48% 0° to 90°—10%



Units of this design have the same character of distribution as open types, with cover plate serving to exclude the dust and dirt from the lamp and reflecting surfaces of the unit. They have the decided advantage from the standpoint of cleaning accompanied, however, by considerable sacrifice in the total light output of the unit.

Coefficients of Utilization about 20% less than open top units of the same design.

23

Ornamental Lantern Art Glass Panels Diffusing Bottom Plate Internal Reflector

90° to 180°—8% 0° to 90°—40%



Lanterns of period designs to conform architecturally to interiors, are frequently used in public buildings, notably churches. Reflectors inside of the ornamental housing increase the lighting efficiency and if made of glass may be made to transmit varying amounts of light to illuminate the side panels. Subject to a variety of design in which distribution ranges from direct to totally indirect lighting.

Coefficients of Utilization for the type of unit illustrated will average about two-thirds of the values given for Unit No 2.

24

Multiple Light Clusters Small Frosted Lamps



Multi-light clusters are in favor as decorative elements in public buildings and other monumental interiors. When mounted high with a large number of low wattage lamps, the result is not unsatisfactory. However, when mounted low, the uncontrolled distribution of light and the glare from the unshielded sources, spoils what would otherwise be an artistic effect.

Lighting efficiency about 50% lower than same wattage in single lamp unit.

25

Large Main Unit Small Decorative Lamps



The application of shades to multi-light units will, in many instances, raise the over-all effectiveness of the installation. On the other hand, the illuminating qualities of large decoration designs can be materially improved if the decorative lamp clusters are built around a central large-lamp unit either of the indirect type or of dense enclosing glassware. A combination of this sort offers a greater flexibility in control of lighting effects, and, in most cases, will allow the illumination level to be raised by the use of a larger lamp in the main unit at any time if the occasion requires.

TABLE No. 7 (Continued) SPECIAL PURPOSE INDUSTRIAL UNITS

26

Deep Bowl Enameled Steel Clear Lamp 90° to 180°—0% 0° to 90°—65%



Generally inferior to RLM Dome with white-bowl lamp because of lower efficiency, sharp shadows, and reflected glare when used above shiny surfaces. Contrary to a common impression the light at any angle from a deep bowl steel reflector is generally less than that from the RLM Standard Dome.

Coefficients of Utilization average about 15% lower than those given for Unit No. 4.

27

Prismatic Reflector
Clear Lamp
90° to 180°—20%
0° to 90°—74%



Highly efficient reflector which, by modification in design, can be made to give extensive, broad, or narrow light distribution characteristics. With clear lamps it is difficult to avoid sharp shadows and reflected glare, and these factors are serious handicaps to a more general use of this type of unit, particularly at usual mounting heights. White-bowl lamps, properly positioned, help these factors, although their use sacrifices, to some extent, accurate control of light distribution as well as the efficiency.

Coefficients of Utilization about 15% higher than those given for Unit No. 9.

28

Mirrored Glass Reflector Clear Lamp 90° to 180°—0% 0° to 90°—69%



This unit like all deep-bowl types has a large shielding angle to protect against direct glare; it likewise has the disadvantage in that it does not protect against reflected glare nor does it avoid sharp shadows when used with clear lamps. The use of white-bowl lamps lowers the efficiency of the unit about 20%, due to the light being bottled up in the reflector, and, in general, are not recommended.

Coefficients of Utilization are about 10% lower than those given for Unit No. 4.

29

Concentrating Aluminum Reflector Dust-tight Housing 90° to 180°—0% 0° to 90°—57%



This unit has an aluminum reflector inside of a dust tight housing. The reflector insert gives a concentrated distribution and a consequent higher utilization factor in high narrow interiors than would be the case with Unit No. 3. Its lower efficiency, compared to Unit No. 7, limits the use of this unit to locations where excessive dirt and smoke prevail.

Coefficients of Utilization average about 20% lower than those given for Unit No. 7.

30

Vapor-proof Fitting Enameled Steel Reflector with Glass Enclosing Globe 90° to 180°—0% 0° to 90°—68%



Designed for locations where corrosive vapor, inflammable gases, or explosive dusts are likely to be encountered. In moisture laden atmospheres such as canning processes, engine rooms, shower baths; also where gases and vapors from such processes as oil refining, varnish making, spray lacquer painting and the like are present, units of this character are recommended. See also Unit No. 31.

Coefficients of Utilization about 10 to 15% lower than for an open reflector.

31

Vapor-proof Fitting Prismatic Enclosing Globe 90° to 180°—28% 0° to 90°—57%



Applications same as for Unit No. 30; the glass reflector is usually not subject to corrosive action and holders are obtainable in a variety of metals and compositions to withstand corrosion from acid vapors of chemical plants. Recommended also in grain elevators, spice, flour and feed mills, in the manufacture of powdered sugar, cornstarch, sulphur, etc., where explosive dusts are present.

Coefficients of Utilization about the same as for Unit No. 9.

32

Angle Reflector Enameled Steel Output 74%



Often used in craneways mounted below cranerail to supplement general overhead system in building up illumination on lateral surfaces. Used also to light individual machines where processes demand special distribution or direction of light. Special care must be taken in locating units to avoid glare; in general, they should be placed high.

33

Local Lighting Unit Substantial Reflector and Holder Cover Plate Output 45-55%



To supplement general lighting where operations require high levels of illumination of the order of 50 to 100 foot-candles where general lighting of at least 10 foot-candles is provided. Local lamps are subject to much handling and for this reason glass cover plates are recommended to protect reflecting surface from grease and dirt; construction must be substantial; reflectors should not be supported by socket shell.

25 to 60-watt inside frosted lamps will generally provide the level of illumination required.

COLOR QUALITY—APPLICATION OF ARTIFICIAL DAYLIGHT

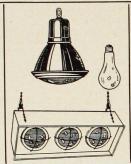
A few years ago discussions of artificial daylight were centered about units built on theoretical lines and of somewhat uncertain performance. Today, good practical units are being marketed and consequently the field for such units has broadened beyond the original conception of limited applications in stores and textile industries.

The duplication of natural daylight is confined largely to those industrial and commercial applications involving accurate color discrimination or color rendition in varying degree, depending upon the specific requirements. Even in this field difficulties arise because the colorist has been accustomed, perhaps through years of habit, to a specific daylight quality peculiar to his location. It is practical and expedient, however, to provide exact reproductions of daylight for any given requirement with the attendant advantage of constancy and 24-hour availability.

Although color quality is accurately specified by color temperature designations, equipments for reproducing daylight for working purposes may be grouped roughly into (1) skylight units, (2) sunlight units, and (3) units which provide a whiter light than the common types of general lighting equipment, but not so white as those listed under (1) and (2).

34 Skylight Quality Special Color Filter

Clear Lamp



Equipments of this character employ accurately correcting filters by means of which it is possible to duplicate the color of outdoor daylight. Generally designed for localized lighting over counters in stores, for small areas or special operations in industrial plants where precision in color identification, grading, and other color inspection is required. Illumination of the order of 100 foot-candles is desirable for this sort of work.

Color factories, paint and dye mixing, art studios, chemical analysis, dental mechanics, surgery, textile and cigar sorting and grading are examples suggesting the application of skylight reproducing equipment.

As compared to unmodified artificial light, from 6 to 8 times the wattage is required for the same foot-candle values.

35 Sunlight Quality Reflector and Color Correcting Globe

Clear Lamp



Enclosing globes of special crystal blue glass frosted on the inside modify the light from a lamp to approximate the color of direct sunlight at noon. Their applications are to some extent the same as skylight units, the actual choice depending on specific requirements; in general, noon sunlight equipment is used for less exacting color discrimination. For example, ink and dye mixing, and inspection may be done locally under skylight quality, and a general system of noon sunlight equipment may be installed in certain rooms or over small areas restricted to manufacturing operations requiring clear color rendition—such, for example, as lithographing processes, color printing and the like.

As compared to unmodified artificial light, from 2 to 3 times the wattage is required for the same foot-candle values.

36 Ordinary Equipment Blue Bulb Daylight Lamps



Lamps with blue bulbs, commercially known as Mazda "Daylight" lamps, emit a whiter light which is but a partial step toward daylight whiteness. In many instances of color step toward daylight whiteness. In many instances of color rendition, their use gives sufficient color correction to be of considerable advantage over the warmer tones of unmodified light. For example, they are widely used in stores and show windows to improve the display of merchandise. Again the light blends well with natural daylight; in fact in many cases it is about the same color as the daylight which one gets indoors taking into account the prevalence of warm tones in window shades. walls and hangings; for this reason the use of daylight lamps in offices and many other places will be found to correct an unsatisfactory mixture of ordinary artificial light to correct an unsatisfactory mixture of ordinary artificial light and inadequate daylight.

The next larger size of lamp will be required to produce approximately the foot-candle level as computed for a clear lamp of a given size. They are used in all common types of equipment.

37 Color Modifying Globes Clear Lamp



Enclosing globes with slight bluish ingredient do not appreciably modify the color quality of illumination for utilitarian purposes, but have a considerably field of application by virtue of their whiter appearance. Such equipment correct for the yellowish tone usually noticeably with ordinary opal glassware. These usually give far less color correction than MAZDA Daylight lamps. The units are very pleasing, appear white and clean, and are often more satisfactory than units of yellowish tone, particularly when supplementing natural daylight. The spectral quality of illumination is usually not far from that of a clear bulb MAZDA C lamp.

Coefficients of Utilization will be about 10% to 30% less.

Coefficients of Utilization will be about 10% to 30% less than the values given for Unit No. 8.

4. Lamp Size—Lumen Output Required

TABLE 8—COMPUTED ILLUMINATION VALUES

In this table the actual foot-candles have been worked out for many different cases, assuming the average foot-candles in service to be 70 per cent of the initial illumination.

Area in							CO	EFFI	CIE	NT (OF U	JTII	LIZA	TI	ON				
Sq. Feet	Size o	f Lamp	.14	.16	.18	.20	.22	.25	.28	.32	.36	6 .4	0 .	45	.50	.55	.60	.65	.70
per Lamp	Watts	Lumens						F (00	T - (-	-							
60	100 150 200 300	1350 2300 3200 5300	2.2 3.8 5.2 8.7	4.3	4.8 6.7 11.1	7.5 12.4	5.9 8.2 13.6	6.7 9.3 15.5	7.5 10.5 17.5	8.6 5 11.9 8 19.8	9 13 . 3 22 .	7 10 4 14 3 24	.7 1: .9 10 .7 2	2.1 6.8 7.8	13.4 18.7 30.9	14. 20. 34.	3 16. 5 22. 6 37.	1 17. 4 24. 1 40.	2 11.0 4 18.8 3 26.1 2 43.3
.70	100 150 200 300	1350 2300 3200 5300	4.5	2.2 3.7 5.1 8.5	4.1 5.8	4.6	5.1	5.5	6.4	1 7.4	1 8. 2 11.	$\frac{3}{5} \frac{9}{12}$.2 10	$0.3 \\ 1.4$	11.5	$\frac{12}{17}$	5 13.1 5 19.1	3 14. 2 20	8 9.4 9 16.1 8 22.4 4 37.1
80	100 150 200 300	1350 2300 3200 5300	1.7 2.8 3:9 6.9	4.5	3.6	4.0 5.6	6.2	7.0	5.6	6.4	1 7.	2 8 1 11	.1 9	9.1	10.1 14.0	11.	1 12.1	1 13.	7 8.3 1 14.1 2 19.6 1 32.5
90	100 150 200 300	1350 2300 3200 5300	1.5 2.5 3.5 5.8	$\frac{2.9}{4.0}$	4.5	3.6 5.0	3.9	6.2	5.0	5.	6.	4 7 0 10	.2 8	1.2	$\frac{8.9}{12.4}$	9.	10.7	111.	8 7.4 6 12.5 1 17.4 8 28.9
100	100 150 200 300	1350 2300 3200 5300	1.3 2.3 3.1 5.1	2.6	2.9 4.0	3.2 4.5	3.5	4.0 5.6	6.3	5.5	2 5.	8 6 1 9	.0 1	7.2	8.1 11.2	8.12.	9.7	7 10. 4 14.	1 6.6 5 11.3 6 15.7 1 26.0
110	100 150 200 300	1350 2300 3200 5300	1.2 2.0 2.9 4.7	2.3	2.6 3.7	2.9 4.1	3.2	3.7 5.1	4.1	6.	5 7	3 5 8	.9 ($\frac{6.6}{9.2}$	$\frac{7.3}{10.2}$	8.	8.8	9.	6 6.0 5 10.2 2 14.3 9 23.6
120	100 150 200 300	1350 2300 3200 5300	1.1 1.9 2.6 4.3	$\frac{2.1}{3.0}$	2.4 3.4	2.7 3.7	3.0 4.1	3.4	3.8 5.2	3 4.3	3 4. 6.	7 7	.4 6	$\frac{6.0}{3.4}$	6.7	7.4	3 11.2	8.	1 5.5 7 9.4 1 13.1 1 21.6
130	150 200 300 500	2300 3200 5300 9500		2.8 4.6	3.1 5.1	3.4 5.7	3.8	4.3 7.1	4.8	5.5	6.	2 6 3 11	.9 1	8.5	$8.6 \\ 14.3$	9.1	10.3	18.	0 8.7 2 12.1 6 20.0 2 35.8
140	150 200 300 500	2300 3200 5300 9500	1.6 2.2 3.7 6.7	2.6 4.2	2.9	3.2	3.5	6.6	4.5	5.1	5.	8 6 5 10	.6 1	7.2	$\frac{8.0}{13.3}$	8.8	9.6	10.	8.1 4 11.2 2 18.6 9 33.3
150	150 200 300 500	2300 3200 5300 9500	1.5 2.1 3.5 6.2	2.4 4.0	2.7 4.5	3.0	3.3	2.7 3.7 6.2 11.0	6.9	2 4.8	5.	4 6 9	.0 6	5.7	7.5 12.4	8.3	9.0	9.	7.5 710.5 117.3 31.0
160	150 200 300 500	2300 3200 5300 9500	1.4 2.0 3.2 5.8	2.2 3.7	2.5	2.0 2.8 4.6 8.3	5 1	5 8	6 5	7 /	1 8	3 9	3 10	1 4	11 6	112.8	13.9	15.	7.0 1 9.8 1 16.2 29.1
170	150 200 300 500	2300 3200 5300 9500	1.3 1.8 3.1 5.5	2.1 3.5	2.4 3.9	2.6	2.9	3.3	6.	7 4.5) 7	7 5 9 8	.3 3	5.9	6.6	12.0	7.9	14.	6.6 9.2 15.3 4 27.4
180	150 200 300 500	2300 3200 5300 9500	1.3 1.7 2.9 5.2	2.0 3.3	2.2 3.7	2.5 4.1	2.7	3.1	3.5	4.6	3. 4. 7. 313.	5 5 4 8	0 5	6.6	6.2	6.8	7.5	8	8 6.3 8.7 4 14.4 25.9
190	150 200 300 500	2300 3200 5300 9500	1.2 1.7 2.7 4.9	1.9	2.1 3.5	3.9	2.6	2 9	3.3	6 5	4.	2 4.	7 5	8	5.9	10.7	7.1	12.	5.9 8.3 13.7 24.5

LAMP SIZE—LUMEN OUTPUT REQUIRED

TABLE 8—COMPUTED ILLUMINATION VALUES

After the layout has been made and the coefficient of utilization determined, the foot-candles produced by various sizes of lamps can be obtained directly from this table.

- 1							COI	EFFI	CIE	NT	OF	UT	ILI	ZAT	ION				
Area in Sq. Feet	Size of	Lamp	.14	.16	.18	.20	.22	.25	.28	.32	.3	6	.40	.45	.50	.55	.60	.65	.70
per Lamp	Watts L	umens						FC	0 7	Γ - (CA	NI	L	ES	1				
200	200 300 500 750	3200 5300 9500 14800	1.6 2.6 4.7 7.3	1.8 3.0 5.3 8.3	2.0 3.3 6.0 9.3	3.7	$2.5 \\ 4.1 \\ 7.3 \\ 11.4$		$\frac{5.2}{9.3}$	5. 10.		.7	3.3	8.3 15.0	9.3		$\frac{11.1}{20.0}$	$\frac{12.1}{21.6}$	$13.0 \\ 23.3$
220	200 300 500 750	3200 5300 9500 14800	1.4 2.4 4.2 6.6	1.6 2.7 4.8 7.5	1.8 3.0 5.4 8.5	3.4 6.0	$\frac{3.7}{6.7}$	2.5 4.2 7.6 11.8	4.7	5. 9.		.1		7.6	5 15.1	9.3	18.1	11.0 19.7	$ \begin{array}{c c} 7.1 \\ 11.8 \\ 21.2 \\ 33.0 \end{array} $
240	200 300 500 750	3200 5300 9500 14800	1.3 2.2 3.9 6.0	1.5 2.5 4.4 6.9	1.7 2.8 5.0 7.8	3.1 5.5	$\frac{3.4}{6.1}$	6.9	4.3	4.8.	0 3 9 5 9 10 8 15	.6	11.1	7.0	$\begin{array}{c c} 7.7 \\ 513.9 \end{array}$	$\begin{vmatrix} 8.5 \\ 15.2 \end{vmatrix}$	9.3	18.0	6.5 10.8 19.4 30.2
260	200 300 500 750	3200 5300 9500 14800	1.2 2.0 3.6 5.6	1.4 2.3 4.1 6.4	1.6 2.6 4.6 7.2	2.9	5 6	3.6	4:0	4.	8 3 6 5 2 9 8 14	.1	10.2 15.9	6. 11. 17.	4 7.1 5 12.8 9 19.9	7.8	8.6	9.3	6 6.0 3 10.0 5 17.9 27.9
280	200 300 500 750	3200 5300 9500 14800	1.1 1.9 3.3 5.2	1.3 2.1 3.8 5.9	1.4 2.4 4.3 6.7	2.6 4.8	2.9 5.2	3.3	3.7	4.	2 4	3.6	9.5	3. 6. 10. 16.	7 11.9	$ \begin{array}{c c} 4.4 \\ 7.5 \\ 13.1 \\ 20.4 \end{array} $	7.9	8.6	
320	200 300 500 750	3200 5300 9500 14800	$ \begin{array}{ c c } 1.0 \\ 1.6 \\ 2.9 \\ 4.5 \end{array} $	1.9	1.3 2.1 3.7 5.8	2.3	$\frac{2.6}{4.6}$	2.9 5.2	3.2	3 6	. 2 2 . 7 4 . 7 7 . 4 11	1.2	2.8 4.6 8.3 13.0	5.	$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{bmatrix} 3 & 3 & 6 & 2 \\ 6 & 6 & 2 \\ 4 & 11 & 4 \\ 2 & 17 & 8 \end{bmatrix}$	1 7.0 1 12.5	7.5	
360	300 500 750 1000	5300 9500 14800 21000	$ \begin{array}{ c c c } 1.4 \\ 2.6 \\ 4.0 \\ 5.7 \end{array} $	3.0	3.3	3.7	6 3	4.6	5.3	2 5	.3 .9 .2 .1	5.6	11 5	8.	3 9.2	4 15	2 11.	1 12.	7 7.2 0 12.9 7 20.1 5 28.6
400	300 500 750 1000	5300 9500 14800 21000	$ \begin{array}{ c c c } 1.3 \\ 2.3 \\ 3.6 \\ 5.1 \end{array} $	$\frac{2.7}{4.1}$	3.0	$\begin{bmatrix} 3.3 \\ 5.2 \end{bmatrix}$	3.7	4.2	4.	7 5	.3	9 3	10 4	7.	5 8 7 13.	0 14.	$\begin{array}{c c} 1 & 10 \\ 2 & 15 \end{array}$	$\begin{array}{c c} 0 & 10 \\ 5 & 16 \end{array}$	0 6.5 8 11.6 8 18.1 9 25.7
450	300 500 750 1000	5300 9500 14800 21000	$ \begin{array}{ c c c } 1.2 \\ 2.1 \\ 3.2 \\ 4.6 \end{array} $	2.4	2.7	$\begin{bmatrix} 3.0 \\ 1 & 4.6 \end{bmatrix}$	3.3	3.7	4.	1 4 7	7	8 3	5.9	0 6.	7 7.4	$\begin{array}{c c} 4 & 8 \\ 5 & 12 \\ \end{array}$	1 8. 7 13.	9 9. 8 15.	4 5.8 6 10.3 0 16.1 2 22.9
500	300 500 750 1000	5300 9500 14800 21000	$ \begin{array}{ c c c } 1.0 \\ 1.9 \\ 2.9 \\ 4.1 \end{array} $	2.1	3.	4 2.7 7 4.2	2.9	3.3	3.	7 4 6	.3	2.7 4.8 7.5 0.6	8 :	3 6. 3 9. 3 13.	2 14.	7 7. 4 11. 7 16.	$ \begin{vmatrix} 3 & 8 \\ 4 & 12 \\ 2 & 17 \end{vmatrix} $	$\begin{bmatrix} 0 & 8 \\ 5 & 13 \end{bmatrix}$	
600	500 750 1000 1500	$\begin{array}{c} 9500 \\ 14800 \\ 21000 \\ 33000 \end{array}$	$ \begin{array}{ c c c } \hline 1.6 \\ 2.4 \\ 3.4 \\ 5.4 \end{array} $	3.9	3.4.	1 3.5	3.8	4.3	3 4.	8 5	.5	6.2	9	9 7. B 11	0 12	6 9. 3 13. 3 21.	$ \begin{array}{c c} 5 & 10 \\ 5 & 14 \\ 2 & 23 \\ \end{array} $	7 15.	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$
700	500 750 1000 1500	$\begin{array}{c} 9500 \\ 14800 \\ 21000 \\ 33000 \end{array}$	$ \begin{array}{c c} 1.3 \\ 2.1 \\ 2.9 \\ 4.7 \end{array} $	2.4	3.	$ \begin{array}{c cccc} 7 & 3.0 \\ 8 & 4.2 \end{array} $	3.3	3.3	4.	1 4	7	$\frac{5.3}{7.6}$	5.8 8.4 13.3	9 6.4 9.2 14.	7 7. 5 10. 9 16.	4 8. 5 11. 5 18.	1 8. 6 12. 2 19.	9 9. 6 13. 8 21.	2 6.7 6 10.4 7 14.7 5 23.1
800	500 750 1000 1500	9500 14800 21000 33000	$ \begin{array}{ c c c } 1.2 \\ 1.8 \\ 2.6 \\ 4.6 \end{array} $	3 2.1	2.	$\frac{3}{3}$ $\frac{2.6}{3.3}$	2.8	3 3 . 2	3.55.	6 4 1 5 1 9	.1 .9 .2 1	0.4	5.2 7.4 11.6	1 8 1 3 1 3 1	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	4 15.	1 7. 1 11. 9 17.	3 18.	4 9.1 9 12.9 8 20.2
900	500 750 1000 1500	9500 14800 21000 33000	1.1 1.2 3.	5 1.3 3 2.6	3 2.	1 2.3 9 3.3	3 2.	5 2.9	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	2 3 5	.7	2.7 4.1 5.9 9.2	4.	6 5	3 8	8 6.	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	$\begin{array}{c c} 9 & 7 \\ 8 & 10 \end{array}$	8 5.2 5 8.1 6 11.4 7 18.0

LAMP SIZE-LUMEN OUTPUT REQUIRED

Formulas for Computing Lamp Size

After the outlets have been located on the plan, the size of lamp to be used may be determined by the following calculation:

- (A) Area in Square Feet = $\frac{\text{Total Floor Area in Square Feet}}{\text{Number of Outlets}}$
- $(B) \begin{array}{c} \textbf{Lamp Lumens} \\ \textbf{Required per} \\ \textbf{Square Foot} \end{array} = \frac{\textbf{Foot-Candles}}{ \begin{array}{c} \textbf{Coefficient} \\ \textbf{of} \\ \textbf{Utilization} \end{array} \begin{array}{c} \textbf{Probable Average Illumination} \\ \textbf{in Per Cent of Initial} \\ \textbf{Illumination} \end{array}$
- (C) Required per = per Outlet × per Square Foot
 Outlet (From A) (From B)

Having determined the lamp lumens required per outlet by the above calculations, the wattage of Mazda lamps to be used may be found by reference to Table 9, below, which lists the lumen output rating for each size of Mazda clear and Mazda Daylight lamps. Locate in this table the size of lamp of the desired type which most nearly meets the requirements of lumen output. When the lamp lumens required fall nearly midway between two sizes, it will usually be found best to choose the larger size.

TABLE 9-LUMEN OUTPUT OF MULTIPLE MAZDA LAMPS

Subject to change without notice

	-120 Volt		5-120 Volt	220-230-2	40-250 Volt
Standard Lig	ghting Service	Standard L	ighting Service		rvice
Clear	Lamps	MAZDA Da	aylight Lamps	Clear	Lamps
Size of		Size of		Size of	
Lamp in	Lumen	Lamp in	Lumen	Lamp in	Lumen
Watts	Output	Watts	Output	Watts	Output
100	1350	100	900	100	1040
150	2300	150	1500		
200	3200	200	2100	200	2700
300	5300	300	3500	300	4300
500	9500	500	6200	500	8100
750	14800			750	13000
1000	21000			1000	18200
1500	33000			1500	27300

LIST OF MANUFACTURERS

AND COUNTY OF	TD	ADE NAME OF UNIT
MANUFACTURER	IN	ADE NAME OF CIVIT
Unit No. 1 (60 to 1500 watts)		
*Benjamin Electric Manufacturing Co	-	
*Ivanhoe Division of the Miller Co	_	
*Westinghouse Electric and Manufacturing Co *Wheeler Manufacturing Co		DIM C. L. ID
*National Screw and Manufacturing Co	- }	RLM Standard Dome
Overbagh and Ayres Manufacturing Co	-	
Quadrangle Manufacturing Co	-	
Central States G. E. Supply Co	-)	
Unit No. 2 (150 to 500 watts)		Cl I D:C
Manufacturers marked (*) under Unit No. 1	- 1	Glassteel Dilluser
Unit No. 3 (60 to 500 watts)		
Ivanhoe Division of the Miller Co Benjamin Electric Manufacturing Co Wheeler Reflector Co	-	DIM Dust tight
Benjamin Electric Manufacturing Co	-	KLW Dust-tight
	-)	
Unit No. 4 (60 to 1500 watts) Same as for Unit No. 1		RLM Standard Dome
Unit No. 5 (500 to 1500 watts)		
Holophane Glass Co	L	Holophane
Unit No. 6 (750 to 1500 watts)		
Dittsburgh Reflector Co		Permaflector
Pittsburgh Reflector Co		Jumbo
Unit No. 7 (750 to 1500 watts)		
Ivanhoe Division of the Miller Co	-	Industrial Flood
Unit No. 8 (100 to 500 watts)		
Flattened globes of this character are made	la bar	1 limbing alagamara
	ie by	most lighting glassware
manufacturers and marketed under various t	rade	names. The best quality
manufacturers and marketed under various t	trade et be	sufficiently diffusing that
manufacturers and marketed under various twill have a light output of about 80% and y the globe is of uniform brightness. The min	trade et be	sufficiently diffusing that
manufacturers and marketed under various twill have a light output of about 80% and y the globe is of uniform brightness. The min given lamp wattage is as follows:	trade ret be nimur	sufficiently diffusing that a diameter of globe for a
manufacturers and marketed under various twill have a light output of about 80% and y the globe is of uniform brightness. The min given lamp wattage is as follows:	trade ret be nimur	sufficiently diffusing that a diameter of globe for a
manufacturers and marketed under various to will have a light output of about 80% and y the globe is of uniform brightness. The mingiven lamp wattage is as follows: 150 watts12-inch 300 200 watts14-inch 500	trade ret be nimur	sufficiently diffusing that a diameter of globe for a
manufacturers and marketed under various to will have a light output of about 80% and y the globe is of uniform brightness. The mingiven lamp wattage is as follows: 150 watts12-inch 300 200 watts14-inch 500 Unit No. 9 (100 to 500 watts)	trade vet be nimur watt) watt	sufficiently diffusing that a diameter of globe for a s16-inch s18-inch
manufacturers and marketed under various to will have a light output of about 80% and y the globe is of uniform brightness. The min given lamp wattage is as follows: 150 watts12-inch 200 watts14-inch 500 Unit No. 9 (100 to 500 watts) Holophane Glass Co	trade vet be nimur watt) watt	sufficiently diffusing that a diameter of globe for a
manufacturers and marketed under various to will have a light output of about 80% and y the globe is of uniform brightness. The mingiven lamp wattage is as follows: 150 watts12-inch 200 watts14-inch 500 Unit No. 9 (100 to 500 watts) Holophane Glass Co	trade ret be nimur Twatt watt -	sufficiently diffusing that a diameter of globe for a s16-inch s18-inch RR (Reflector-Refractor)
manufacturers and marketed under various to will have a light output of about 80% and y the globe is of uniform brightness. The mingiven lamp wattage is as follows: 150 watts12-inch 200 watts14-inch 500 Unit No. 9 (100 to 500 watts) Holophane Glass Co	trade ret be nimur Twatt watt -	sufficiently diffusing that a diameter of globe for a s16-inch s18-inch RR (Reflector-Refractor)
manufacturers and marketed under various to will have a light output of about 80% and y the globe is of uniform brightness. The mingiven lamp wattage is as follows: 150 watts12-inch 200 watts14-inch 500 Unit No. 9 (100 to 500 watts) Holophane Glass Co Unit No. 10 (100 to 500 watts) Goodrich Electric Co Beardslee Chandelier Co	trade ret be nimur Twatt watt -	sufficiently diffusing that a diameter of globe for a s16-inch s18-inch RR (Reflector-Refractor)
manufacturers and marketed under various to will have a light output of about 80% and y the globe is of uniform brightness. The mingiven lamp wattage is as follows: 150 watts12-inch 300 200 watts14-inch 500 Unit No. 9 (100 to 500 watts) Holophane Glass Co	trade ret be nimur Twatt watt	sufficiently diffusing that a diameter of globe for a s16-inch s18-inch RR (Reflector-Refractor)
manufacturers and marketed under various to will have a light output of about 80% and y the globe is of uniform brightness. The ming given lamp wattage is as follows: 150 watts12-inch 200 watts14-inch 500 Unit No. 9 (100 to 500 watts) Holophane Glass Co	trade ret be nimur Twatt watt	sufficiently diffusing that a diameter of globe for a s16-inch s18-inch RR (Reflector-Refractor)
manufacturers and marketed under various to will have a light output of about 80% and y the globe is of uniform brightness. The ming given lamp wattage is as follows: 150 watts12-inch 200 watts14-inch 500 Unit No. 9 (100 to 500 watts) Holophane Glass Co	trade ret be nimur Twatt watt	sufficiently diffusing that a diameter of globe for a s16-inch s
manufacturers and marketed under various to will have a light output of about 80% and y the globe is of uniform brightness. The ming given lamp wattage is as follows: 150 watts12-inch 200 watts14-inch 500 Unit No. 9 (100 to 500 watts) Holophane Glass Co	trade ret be nimur Twatt watt	sufficiently diffusing that a diameter of globe for a s16-inch s
manufacturers and marketed under various to will have a light output of about 80% and y the globe is of uniform brightness. The ming given lamp wattage is as follows: 150 watts12-inch 200 watts14-inch 500 Unit No. 9 (100 to 500 watts) Holophane Glass Co	trade ret be nimur Twatt watt	sufficiently diffusing that a diameter of globe for a s
manufacturers and marketed under various to will have a light output of about 80% and y the globe is of uniform brightness. The ming given lamp wattage is as follows: 150 watts12-inch 200 watts14-inch 500 Unit No. 9 (100 to 500 watts) Holophane Glass Co	trade ret be nimur Twatt watt	sufficiently diffusing that a diameter of globe for a s
manufacturers and marketed under various to will have a light output of about 80% and y the globe is of uniform brightness. The mingiven lamp wattage is as follows: 150 watts12-inch 200 watts14-inch 500 Unit No. 9 (100 to 500 watts) Holophane Glass Co	trade ret be nimur Twatt watt	sufficiently diffusing that a diameter of globe for a s
manufacturers and marketed under various to will have a light output of about 80% and y the globe is of uniform brightness. The mingiven lamp wattage is as follows: 150 watts12-inch 200 watts14-inch 500 Unit No. 9 (100 to 500 watts) Holophane Glass Co	trade ret be nimur Twatt watt	sufficiently diffusing that a diameter of globe for a s16-inch s18-inch RR (Reflector-Refractor) Clear Top 99 Reflex Red Spot Office Unit
manufacturers and marketed under various to will have a light output of about 80% and y the globe is of uniform brightness. The ming given lamp wattage is as follows: 150 watts12-inch 200 watts14-inch 200 watts	trade ret be nimur Twatt watt	sufficiently diffusing that a diameter of globe for a s
manufacturers and marketed under various to will have a light output of about 80% and y the globe is of uniform brightness. The mingiven lamp wattage is as follows: 150 watts12-inch 200 watts14-inch 500 Unit No. 9 (100 to 500 watts) Holophane Glass Co	trade ret be nimur Twatt watt	sufficiently diffusing that a diameter of globe for a s
manufacturers and marketed under various to will have a light output of about 80% and y the globe is of uniform brightness. The ming given lamp wattage is as follows: 150 watts12-inch 200 watts14-inch 200 watts	trade ret be nimur Twatt watt	sufficiently diffusing that a diameter of globe for a s

LIST OF MANUFACTURERS

MANUFACTURER	TR	ADE NAME OF UNIT						
Unit No. 17 (100 to 1500 watts) Curtis Lighting, Inc	-	X-Ray						
Unit No. 18 (25 to 150 watts)								
Made by most Lighting Glassware Manufacturers.								
Unit No. 19 (60 to 1000 watts) Made by most Lighting Glassware Manufacturers.								
Unit No. 20 (100 to 500 watts) Planetlite Company, Inc	-	Planetlite Brascolite						
Unit No. 21 (100 to 500 watts) Art stores and studios, in general, make a specialty of executing designs in								
silk, parchment, and other suitable shade materials.								
Unit No. 22 (100 to 500 watts) The Duplexalite Division of the Miller Com-	pany	Duplexalite						
Units Nos. 23, 24, 25 Specifically designed ornamental equipments will be made up according to specification by a considerable number of lighting fixture manufacturers.								
Unit No. 26 (25 to 1500 watts) Same as list for Unit No. 1	-	Deep Bowl Steel						
Unit No. 27 (100 to 500 watts) Holophane Glass Co	-	Holophane Prismatic						
Unit No. 28 (100 to 500 watts) Curtis Lighting, Inc	-							
Unit No. 29 (200 to 500 watts) Ivanhoe Division of the Miller Co	-	Industrial Floodlight						
Unit No. 30 (60 to 500 watts)								
Benjamin Electric Manufacturing Co. Ivanhoe Division of the Miller Co. Wheeler Reflector Co		Vapor Proof						
Unit No. 31 (40 to 200 watts) Holophane Glass Co		Vapor Proof						
Unit No. 32 (25 to 1500 watts) Same as list for Unit No. 1	-	Angle Type						
Unit No. 33 (10 to 50 watts)								
Ivanhoe Division of the Miller Co Benjamin Electric Manufacturing Co								
Unit No. 34 (150 to 1000 watts and in multiple MacBeth Daylighting Co Ivanhoe Division of the Miller Co	e units)	MacBeth Trutint						
Unit No. 35 (200 to 1000 watts)								
Ivanhoe Division of the Miller Co		Noon Sunlight						
Unit No. 36 (60 to 500 watts)		M D Plif						
Mazda Lamp Manufacturers		Mazda Daylight Lamp						
Unit No. 37 (100 to 750 watts) Gleason-Tiebout Glass Co		Celestialite Glass						
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- 33B—Motion Picture Projection with MAZDA Lamps
 A practical discussion of the principles of Mazda lamp projection and their application.—48 pages.
 Picture Projection for Business, Education, and the Home is a supple-

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- 44A—Incandescent Lamp Temperatures

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 Presents lighting recipes for a number of typical store interiors, both large and small, together with designs and notes on lighting of the display windows.—48 pages.
- 46A—Street Lighting Designs

 Urges that all cities outline a complete plan and proceed from year to year with an orderly development of a street lighting program. Simple recipes are given for the lighting of business, thoroughfare, and residence streets for cities of various sizes.—20 pages.
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 Analyzes the requirements, describes the equipment, and illustrates the results obtained with MAZDA lamps in portrait and commercial photography.—64 pages.
- Farm Lighting

 Pertinent to the general interest and present widespread activities in farm electrification, this bulletin presents lighting recommendations which are practical and satisfactory for the various farm buildings and the farm home.

 —36 pages.

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